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SUSTAINABLE STRATEGIES FOR ENHANCING FOOD SECURITY AND LIVELIHOODS IN NIGERIA

SUB-THEME 1


AGRIBUSINESS &
MARKETING,
AGRIPRENUERSHIP POLICY &
RESOURCE ECONOMICS

ASN 52nd Annual Conference Proceedings

Constraints to Value Addition in Cassava Processing in Emohua Local Government Area, Rivers State, Nigeria

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Abstract
This study was carried out to examine the constraints to value addition in Emohua Local Government Area, Rivers State, Nigeria. The specific objectives are to identify the socio-economic characteristics of cassava farmers in the area, estimate costs and returns to cassava processing; and identify constraints to cassava processing and marketing. A three-stage random sampling technique was used to obtain primary data from72 respondents used for the study. Descriptive statistics was used to analyze the data used for the study. Analysis of the costs and returns revealed that processing cassava to fufu gave the highest Net Returns even though processing cassava to all the three products was profitable. Furthermore, the constraints experienced by processors in carrying out their activities and marketing their various products include bad roads leading to high transportation cost and high cost of fire wood. The study therefore recommends the need for processors to have access to infrastructural facilities and improved processing technology to enable them take advantage of the emerging market-oriented cassava products so as to improve their means of livelihood.
Keywords: Value Addition, Constraints, Fufu, Tapioca, and Rate of Returns

Introduction
In other to increase the shelf life of agricultural products and also add value to them, it has become necessary to study the various products coming out from cassava, a major staple grown, eaten and traded in different forms in Emohua Local Government Area(LGA) by smallholder farmers to increase their income. Cassava (*Manihotesculenta*), which has its origin from Latin America (Agwu, Anyanwu and Kalu, 2015) has gained global attention as an important root crop in Africa with Nigeria producing the highest quantity (54 million metric tonnes annually) globally (FAO, 2013). This crop, as has been captured by several literatures is a crop that is flexible, withstands drought and diseases and has the ability to thrive on low quality soils (Meridian Institute, 2014).Its roots are good sources of ethanol (Ani, Agbugba, & Baiyegunhi, 2013; Agwu *et al.,* 2015) and are rich in minerals, vitamins, starch and protein (Akpan, Okon, Jeiyol, Nkeme, & John, 2013)
Cassava root is processed into granulated substances called *garri* that is consumed by almost every Nigerian (Akpan *et al.,* 2015). According to Ani (2010) the consumption per capita is very high and it provides about 80 % of the total energy intake of many Nigerians. It can also be processed to get other by-products such as: flour, chips, *Fufu, Tapioca, starch etc* .By processing into other products, there is value addition(which in effect increases the farmer's income) and increase of the shelf life of the crop. However, there are challenges: it is generally observed that there is low level of investment in small scale cassava processing to value added products. This is evident in the predominance of women most of whom are resource poor in cassava processing enterprises; income derived from other products of cassava is small compared to garri and the challenges involved in the process.For these reasons, the study considers the following objectives: identify the socio-economic characteristics of cassava dealers; identify the various products from cassava; determine the costs and returns to cassava value addition and identify the constraints to cassava value addition.

Materials and Methods

The study was carried out in Emohua L.G.A. of Rivers State, Nigeria. It is one of the twenty three (23) Local Government Areas in the State and is divided into two geographical regions: Emohua Central and Emohua North respectively. The study population comprised of male and female cassava producers and processors/marketers operating in the L.G.A. A three-stage random sampling technique was used to select respondents for the study. At stage one three communities each were purposively selected from the two geographical locations (Emohua Central and Emohua North) based on the volume of cassava processing activities. At the second stage, two villages were selected randomly from each of the three communities selected from the two geographical locations to arrive at the twelve villages. At the third stage, six respondents (which include 2-producers, 2-processors and 2-marketers) were identified and randomly selected from each of the 12 villages to arrive at seventy two respondents. A structured questionnaire was used to collect primary data on the quantity of cassava that was used for each product, cost of processing the cassava into the various products like gari, *fufu* and *tapioca* and the cost of cassava that was used. Descriptive statistics such as frequencies and percentages were used to analyze the processing methods of selected cassava products (gari, *fufu* and *tapioca*) in the study area, the constraints associated with their processing and marketing. Rate of returns per naira on investment was used to analyze the returns on investment of marketing of the selected cassava products. Data were analyzed using cost and return analysis, R/C ratio and value addition analysis.

Analytical Method

Data was analyzed using descriptive statistics (means and percentages).The Rate of Return on Investment (RRI) shall be specified as:

$$RRI = \frac{\text{Net Income (NI)}}{\text{Total Cost (TC)}}$$

Where:

N I = TR-TC

TR = Total revenue from the cassava products

TC = TFC + TVC = Total cost of cassava products

TFC = Total fixed cost such as cost of frying pan, sieve, bags, frying spoon, tripod stands, knives, etc.

TVC = Total variable cost such as cost of fresh tuber, cost of transportation, cost of firewood, labour cost, cost of oil, etc.

TC = Total Variable Cost (TVC) + Depreciation

$$\text{Depreciation} = \frac{\text{Total Cost of assets - Salvage value}}{\text{Useful life}}$$

Results and Discussion

Estimated Cost and Returns to Cassava Processing into Garri, *Tapioca* and *Fufu*

The costs and returns to cassava processing into garri, tapioca and *Fufu* are as presented in Table 1. The result from the survey showed that an average of 100Kg of Cassava was processed into *garri* within a production cycle that took an average of five (5) days. The labour costs incurred included cost of peeling, milling, sieving, washing and frying. Milling was mainly done by men. The amount spent on labour on cassava to be processed into garri accounted for 18.18% of the total cost. 13.64% of the total cost was spent on the purchase of fire wood, kerosene and frying pot. The remaining 68.18% of the total cost were accounted for by other inputs. Also, some of the processors add palm oil to their garri in order to differentiate their product as well as enhance acceptability and preference. The average price of garri was ₦ 3,200.00/basin. The Net Returns was estimated at ₦ 1,600.00/100kg of cassava. The implication is that processing cassava to garri is profitable. An average of 100kg of cassava was processed to tapioca over a production cycle of 2-3 days after soaking. While 69.77% of the total costs of processing *tapioca* were incurred on cassava tuber, 14.42% was spent on labour with the remaining 15.81% spent on other inputs. With an estimated price of *tapioca* at ₦3,500.00/basin, the total value was ₦14,000. The Net Returns for processing tapioca was therefore ₦3,250.00/100kg of cassava. This implies that processing cassava to tapioca is a profitable enterprise in the study area. An average of 100kg of cassava was processed to *fufu* over a production cycle of 7 days. While 73.53% of the total costs of processing *fufu* were incurred on cassava tuber, 9.8% was spent on labour with the remaining 16.67% spent on other inputs. With an estimated price of *fufu* at ₦4,000.00/bag the total value was ₦16,000. The Net Returns for processing tapioca was therefore ₦5,800.00/100kg of cassava. This implies that processing cassava to *fufu* was a profitable enterprise in the study area as it brought more earnings than garri and *tapioca*. This is in agreement with findings from Muhammad-Lawal, Omotesho, and Oyedemi (2013) which shows net returns of garri ₦4,343.86; *fufu*₦5,931.28 and *lafun* ₦5,038.84 respectively.

Constraints to Cassava Value Addition

The results of the findings in relation to the constraints faced by the processors during the process of value addition to cassava for the production and marketing of garri, tapioca and *Fufu* are as presented in Table 2. It showed that bad road leading to high transportation cost and high costs of fire wood are serious problems encountered by the processors. This affected the cost of value addition in the area and is in line with the findings of Muhammad-Lawal *et al*. (2013) and Umeh (2013). High cost of kerosene and palm oil are not serious problems encountered by the processors for production of garri, tapioca and *Fufu*. However, the higher returns recorded for tapioca and *Fufu* are as a result of the reduction in labour costs as opposed to the processing of garri.

Conclusion and Recommendations

The analysis of value addition in cassava processing in Emohua LGA showed that in cassava processing there were variations in the Net Returns to the various products of cassava processed. However, *fufu* had the highest returns, this is in spite of the fact that all the products of cassava processing in the area namely garri*, tapioca* and *fufu* are profitable. To be able to derive the highest financial benefits to cassava processing, it is recommended that good roads be constructed in order to reduce the cost of transportation of cassava and its products, Processors are encouraged to go into cooperatives in order to harness their resources and provide themselves with technology that can improve value addition to cassava and that Garri and *fufu* which are the major income earners serve as a comparative advantage over other items from cassava as this would help the women to improve on their income and socioeconomic status.

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Table 1: Costs and �essing

Item	**Garri(₦)**	***Tapioca* (₦)**	***Fufu*(₦)**
Revenue	**12,600.00***	**14,000.00****	**16,000.00*****
Average Cost of Cassava (100kg)	7,500.00	7,500.00	7,500.00
Peeling (Average cost/100kg)	600.00	600.00	600.00
Washing (Average cost/100kg)	200.00	350.00	400.00
Grinding	600.00	0.00	0.00
Frying (Cost for 4 basins)	600.00	0.00	0.00
Cutting/slicing	0.00	600.00	0.00
Fire wood (1 bike load)	1,000.00	1,000.00	1,000.00
Kerosene	200.00	200.00	200.00
Frying/Cooking pot (Depreciation cost)	200.00	500.00	500.00
Palm oil	100.00	0.00	0.00
Total cost of inputs	**11,000.00**	**10,750.00**	**10,200.00**
Net Returns	**1, 600.00**	**3,250.00**	**5,800.00**

Source Field survey, 2017 *4 basins @ ₦ 3,200.00; **4 basins@ ₦ 3,500.00; ***4 bags@ ₦ 4,000.00

Table 2: Constraint of Cassava conversion to other value added products

Product	1	2	3	ΣF	N	Mean	Decision
Garri							
High transportation Cost	5	13	8	55	26	2.11	Serious
High cost of fire wood	2	21	3	53	26	2.04	Serious
High cost of Kerosene	21	4	1	32	26	1.23	Not Serious
High Cost of oil	20	4	2	34	26	1.31	Not Serious
Tapioca							
High transportation Cost	1	5	16	59	22	2.68	Serious
High cost of fire wood	2	6	14	50	22	2.27	Serious
High cost of Kerosene	19	2	1	26	22	1.18	Not Serious
High Cost of oil	16	4	2	30	22	1.36	Not Serious
Fufu							
Bad Road leading to high transportation Cost	1	5	18	65	24	2.71	Serious
High cost of fire wood	2	6	16	62	24	2.58	Serious
High cost of Kerosene	21	2	1	28	24	1.27	Not Serious
High Cost of oil	18	4	2	32	24	1.33	Not Serious

Source: Field survey, 2017 .1=Not Serious; 2=Serious; 3=Very Serious,ΣF=sum of frequency, N=number of respondents

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Effect Of Youth Rural-Urban Migration in Igabi Local Government Area Of Kaduna State, Nigeria

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Abstract
The study was conducted in 2017 to assess the effect of rural–urban migration in Igabi local government of Kaduna State, Nigeria. Data were collected using structured interview from 81 randomly selected farmers and were analysed using descriptive statistics. Results showed that 49.9% are within the age class of 42-60 years. Eighty five percent (85%) of the respondents are male and 87.6% were married. Majority (60.5%) of the respondents went through formal education. More than half (63%) are farmers, of which 42% cultivate between 0.5-3ha of land. Most prominent causes of rural-urban migration are lack of social amenities (77.8%), unemployment (72.8%) and poverty (66.7%).Seventy-two percent (72%) of the respondents indicated that migration resulted in low agricultural productivity, 61.7% decrease in farmers income, 53.1% reduced communal participation among others. It is therefore recommended that social amenities should be provided by all tiers of government to discourage rural-urban migration.
Keywords: Rural-urban migration, social amenities, agricultural production

Introduction
Nigeria was previously an agriculture economy and the agricultural sector was contributing about 80% of the total Nigeria export. Then, about 75% of Nigeria total population live in the rural area and obtain their means of livelihood from agriculture. But ironically, this sector has been doing badly in the past few years for example, in 1965 agricultural export accounted for as much as 76% of the Nigeria foreign exchange, 43% in 1970 while the contribution falls to about 6% in 1976, 3.9% in 1989 and 1.4% in 1992. (African development bank, 2012).
Many factors have contributed to the poor performance of agricultural sector but one of the major factor is rural-urban migration (especially by youth) which involves the shifting of labour force from rural areas to urban centers in search of employment, better living standard, freedom of religion and others too numerous to mention, one of the factor affecting rural-urban pattern of migration is the storage of agricultural labour supply needed for agricultural production (Frimino,2006),Chinsinga, (2015) pointed out that the rural-urban pattern of migration takes more young men than women out of the rural area, resulting in many women becoming the heads of household and been responsible for agricultural production. Frimino, (2006) pointed out that the youth perform the most tedious jobs in the farm. It is also documented that, in most cases, the works of rural youth include, clearing of farm, road, clearing of village street crops and animal processing, livestock raising, artisan production etc. With more youth migration into urban areas to earn a living, more aged people are now left to accomplish the task associated with farming, especially the task which are reserved for the youth. Therefore, there is no doubt the added responsibilities will reduce agricultural production, (Nwosu, 2009). Several factors are responsible for rural urban migration, viz; the rural push factors and the urban pull factors. The rural push factors are family pressure, unemployment, inadequate infrastructure like electricity, good and portable water, good roads, hospitals and persistence of poverty. While the urban pull factors include employment opportunities, presences of infrastructural facilities like good roads, hospitals, good drinking water. This results in the gradual movement of young productive able-bodies, educated and skilled individuals away from the rural areas living behind children, old and unskilled persons thereby resulting in low socio-economic life standard among rural dwellers,

(Adepoju 2006). Rural-urban migration is also associated with a decrease in farmers income, stagnation, rural development, and shortage of labour during cropping season with resultant effect on agricultural production and supply at large. To investigate this problem, the study attempted to describe; the socio-economic characterises of rural farmers, the causes and effects of rural-urban migration in the study area

Methodology

Igabi local government area is in the guinea savannah region of Nigeria on the latitude 10^0 47' 0" North, 7^0 46' 0" East (Maplandia 2012). Its inhabitants are mostly farmers and cattle rearers. Primary data were used in this study. The primary data were obtained from farmers (household heads) through structured questionnaires that were administered along with personal interview. Data were collected in 2017 from 81 Sorghum farmers in Igabi local government using the random sampling technique. Descriptive statistics was used to analyse and summarize the source data through the use of measures of central tendency such as frequency distribution, mean, percentages and ranking procedures.

Results and Discussion

Table 1 presents the socio-economic characteristics of the farmers in the study area. Result revealed that the modal age group of the respondents was 42-61. The minimum age of about 21 years may be an indicator of less participation of youth in farming activities as mostly are engaged in educational activities whilst a reasonable number are engaged in rural-urban migration. This can be evident by the fact that a great proportion (32%) of the respondents had either secondary or tertiary education. The farmers were predominantly male (85.19%). Majority of the respondents were married. More than half (74.9%) of the respondents are literate with most of them possessing minimum of primary school education, while 39.51% had no formal education and 20.99% had tertiary education. This implies that farmers in the study sites can follow simple written instructions and other extension publications for better understanding of the recommendations of agricultural production. About 42% of the respondents had 0.5-3.0ha of farm land, while only 7.41% had 5.5-8.0ha of farm land, signifying that most of the farmers are small scale farmers. Household size of about 10 is the modal class with up to 33.3%, while the minimum is between 11-21 persons consisting of 31% of the population of the respondents. Majority (86.4%) of the farmers had farming as their primary occupation, while about 26% are artisans with small proportion of the respondents in the civil service (9.88%). The result from Table 1 also revealed that 40.7% of the respondents had enjoyed farm credit i.e. they have access to credit.

Table 1: Respondent socioeconomic and institutional factors

Socioeconomic Variables	Options	Frequency	Percent
Age	< 21	1	1.23
	22-41	13	16.05
	42-61	40	49.38
	> 61	27	33.33
Gender	Male	69	85.19
	Female	12	14.82
Marital Status	Divorce	6	7.41
	Married	71	87.65
	Single	4	4.94
	Widow	6	7.41
Educational	Non Formal	32	39.51
	Primary	23	28.39
	Secondary	9	11.11
	Tertiary	17	20.99
Farm size	0.5-3.0	34	41.98
	3.0-5.5	24	29.63
	5.5-8.0	6	7.41
	>8.0	16	19.75
Household size	1 – 10	27	33.33
	11 – 21	25	30.86
	> 21	29	35.8
Primary occupation	Farmer	51	62.97
	Civil servant	8	9.88
	Artisan	21	25.96
Access to Credit	Yes	33	40.74
	No	48	34.29

Source: Field Survey, 2016

Causes of Rural-urban Migration

Several factors have been identified by literatures as the cause of rural-urban migration. In Igabi local government area of Kaduna State the following factors (Table 2) have been identified by the respondents. The leading cause of migration to urban centres is lack of social amenities in the various rural settlements, this accounted for 77.8% and ranked 1st among other causes. Unemployment accounted for 72.8% cause of rural urban migration and ranked 2nd. Other causes of rural urban migration includes poverty (66.7%), poor education (53.1%) and poor standard of living (48.1%). The results agrees to the findings of Ango *et al* (2014), Uddin (2013) and Aworemi *et al* (2011) that lack of social amenities, unemployment and poor education standard are among the factors that highly determine rate at which rural-urban migration takes place. This implies that, the youths engaged in migration to urban settlements do so as a result of constraints due to poor state or lack of social amenities, unemployment and poor education. Possible Government and intervention by all related stakeholders in providing the basic needs of the rural settlers will result to a decrease in the rate of migration to urban centres, which has a direct effect on agricultural productivity the settlements.

Table 2 Causes of Rural-Urban Migration in Igabi LGA

Cause	Percent	Ranking
Lack of social amenities	77.8	1st
Unemployment	72.8	2nd
Poverty	66.7	3rd
Poor education	53.1	4th
Poor standard of living	48.1	5th

Source: field survey 2016. *Multiple Responses recorded

Effects of Rural-urban Migration on Rural Community

Like most themes in social change and development, the problem of rural urban migration and its impact is a complex subject. One thing however is clear; the phenomenon of rural-urban migration is grounded in the persistent inequality in the allocation of social and economic infrastructure such as pipe borne water, good roads, electricity, health facilities, and industries, among others in rural and urban communities. However other effects (Table 3) have been recognized by farmers in the study area. Low agricultural productivity accounts for over 72.8% of the effects of rural urban migration, followed by reduction in farmer's income (61.7%), reduction in communal participation with 53.1%. This implies that, the rate at which youth migrate to urban centers has led to decreased agricultural productivity, which in turn led to a decrease in farmer's income. This is so true because the most energetic of the community had left for a better life in urban centers leaving behind the older ones whom are aged and cannot produce a reasonable quantity of food and even if one has the capital to use hired labour, he still won't get it and the little ones been present will be left with too much to be done. Consequently, since the demand for labour increases, therefore the amount also appreciates.

Table 3 Effects of Rural-Urban Migration in Igabi LGA

Outcomes	Percent	Rank
Low agricultural productivity	72.8	1st
Reduced farmer income	61.7	2nd
Reduced communal participation	53.1	3rd
Older ones are left behind	46.9	4th
Under-development	44.4	5th
Increased cost of agricultural labour	33.3	6th
Loss of traditional activities	18.6	7th

Source: field survey 2016.*Multiple Responses recorded

Conclusion/Recommendations

The study indicated that rural-urban migration has caused a decline in agricultural production in the study area. This is majorly caused by lack of social amenities, unemployment and poverty in the study area. The recommendations that could possible redress the problem of rural-urban migration includes;

i. Provision of social amenities in rural communities by the government
ii. Orientation of the youths on the available opportunities they could invest in their communities.
iii. Building of youth's and the aged persons capacity in activities they can engage in to further increase their revenue and chances of shunning migration to urban centres.

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Determinants of Investment Behaviour among Orange-Fleshed Sweetpotato Root Entrepreneurs in North Central Nigeria

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Abstract
This study examined determinants of investment behaviour in OFSP root production in North Central Nigeria. Multistage sampling was used to select 174 root entrepreneurs in Benue, Nasarawa and Kwara States. Structured questionnaire designed for a single visit was used in data collection. Descriptive statistics was used to achieve objective one and multiple regression analysis was used to realise objective two. The result shows that volume of savings, root output, owned land and root price have positive coefficients and have significant influence on investment behaviour among orange-fleshed sweet potato root entrepreneurs in the study area. Policies to enhance savings; and give access to input and output markets were recommended to improve investment behaviour in OFSP root production in the study area.

Keywords: Investment, Behaviour , Orange Fleshed, Sweetpotato root

Introduction
The importance of orange-fleshed sweet potato (OFSP) in the socio-economic lives of people in Sub-Saharan Africa (SSA) and Nigeria in particular cannot be overemphasized. Orange-fleshed sweetpotato is both an economic and nutritional crop. All parts of the sweetpotato crop can be processed into diverse products of economic or food value (Afuape, 2014). Sweetpotato roots are mostly used for human consumption, animal feed, production of fermentation products (such as wine, liquor) and for sugar production (Eklund *et al*., 2013; Tewe, Ojeniyi, and Abu, 2003). Sweetpotato roots are cooked together with cowpea, lima beans, sesame, millet and or other root crops to make a traditional porridge. Afuape (2014) opined that packaged sweetpotato fries and crisps have emerged as micro- to small-scale business, contributing to employment generation at rural, semi-urban and urban areas. In spite of the enormous benefits of OFSP, it has been observed that there is low level of investment in OFSP production in Nigeria. Fawole (2007) stressed that the main constraint to sweetpotato production sustainability is lack of investment to ensure the availability of quality sweetpotato roots and roots throughout the dry season since they serve as planting materials in the next crop cycle. Sahan and Mikhail (2012) stated that investment in agriculture that focuses on the production of food staples often provides the best opportunities for reducing poverty and improving food security in less developed regions, particularly in Africa. Osundare (2013) noted that very low domestic savings is a major constraint to investment in Africa, including Nigeria. Since investment is always characterized by risk and uncertainty (Amu, Offei-Ansah, Gavor, 2012), especially in agriculture, where poverty is more pronounced among small-scale farmers. This underscores the importance of understanding the investment behaviour among OFSP entrepreneurs. Understanding the determinants of investment behaviour of OFSP entrepreneurs will provides an important insight into the process of capital accumulation that when properly managed lead to economic growth and development. Arising from the forgoing and considering the importance of the OFSP root production in economic growth, sustainable strategies for food security and livelihoods in Nigeria, it is imperative and urgent to investigate the determinants of investment behaviour of OFSP root entrepreneurs in North Central Nigeria. There seem to be a dearth of information on what are the drivers of investment behaviour among OFSP root entrepreneurs in Nigeria. This paper attempted to fill the knowledge gap. The objectives of this study were to: (i) examine OFSP root production systems, and (ii) analyse the determinants of

investment behaviour among orange-fleshed sweetpotato root entrepreneurs in North Central, Nigeria.

Methodology

The study was conducted in the North Central geo-political zone of Nigeria. This geo-political zone was chosen based on the intensity of orange-fleshed sweetpotato root production. Multistage sampling procedure was employed to select the respondents in this study. In first stage, three selected states were Benue, Nasarawa and Kwara were purposively selected based on their distinct OFSP production (National Root Crops Research Institute, NRCRI, 2012).In second stage, Gboko, Konshisha, Vandeikya, and Makurdi were selected from Benue state while Karu, Lafia, Nasarawa Egon, and Jenkwe Development Area were selected from Nasarawa state while Ilorin East, Ifelodun, and Patigi, were selected from Kwara state. In the third stage,174 farm households were randomly selected local government areas based on sampling frame from the respective ADPs for the analysis of determinants of investment behaviour among OFSP root entrepreneurs. Data were collected with aid of structured questionnaire. Descriptive statistics and multiple regression model were used in analysing the data

Results and Discussion

The result of OFSP root production systems is presented in Table 1. The result reveals that the dominant cropping system practiced in OFSP root production is mixed cropping system. About 84.5 percent of the OFSP root households practiced mixed cropping system. This result is in consonance with the findings of Adebisi *et al.*,(2015) which they reported that sweetpotato is intercropped with some major crops such as yam, cassava, maize, soybean in Nigeria. Majority of the sample households (47.7%) practiced cut grass and burn technique of land preparation. The practice of bush burning has serious implication on soil fertility.

Table 1: Distribution of Orange-Fleshed Sweetpotato Root Households by Production System (n=174)

Item	Category	Frequency	Percentage (%)
Cropping System:	Sole cropping	27	15.5
	Mixed Cropping	147	84.5
Land Preparation:	Cut grass and burn	83	47.7
	Use Chemical	34	19.5
	Weed clearing	57	32.8
Land cultivation:	Flat soil	6	3.4
	Ridges	82	47.1
	Mounds	86	49.4
Number of production cycle/year:	Once	64	36.8
	Twice	110	63.2
Weed Control Method:	Manual Weeding	127	73.0
	Chemical	47	27.0
Number of weeding/production cycle:	Once	147	84.5
	More than once	27	15.5
	No	120	69.0
Use of Fertilizer:	Yes	54	31.0
	No	120	69.0
Type of Fertilizer used:	Organic/Animal Waste	119	68.4
	Inorganic	55	31.6
Use of irrigation system:	Yes	38	21.8
	No	136	78.2

Source: Field survey data (2016)

The result reveals that about 49.4 percent used mounds as seed bed for OFSP production. Majority (63 %) of sample OFSP root households cultivate OFSP twice a year. Majority (73 %) of the sample households practiced manual weeding as a method of weed control. This suggests that OFSP root households employed a lot of labour in weed control. The result in Table1 also shows that 84.5

percent Households weed their farm only once per OFSP root production cycle. About 69 percent do not use fertilizer on their OFSP root farms. The result also shows that about 78.2 percent of sample households do not have access to irrigation. The implication is that majority of the OFSP root households depend on rain fed farming, thus surrounding their investment with risk of inadequate rainfall. The result of analysis of determinants of investment behaviour among OFSP root entrepreneurs is presented in Table 2. The double log functional form of multiple regression models was accepted as lead equation based on its high of $R^2$and minimum standard error. The shows that majority of the explanatory variables have positive coefficients. The positive sign implies that these variables have positive influence on investment behaviour among OFSP sweetpotato root entrepreneurs in the study area.

Table 2: Estimates of Determinants of Investment Behaviour among Orange-Fleshed Sweetpotato Root Entrepreneurs (n=174)

	Multiple Linear		Semi log		Double Log	
Variable	Coefficient	P. Value	Coefficient	P. Value	Coefficient	P. Value
Constant	-49755.533(-2.029)	0.015**	-238413.761(-1.970)	0.000***	3.370(3.084)	0.002**
X_1 Volume of Savings	0.308(4.013)	0.000***	3284.949(1.450)	0.000***	0.092(4.501)	0.000***
X_2 Owned Land	0.2586(2.811)	0.000***	0.020(1.421)	0.158	0.185(3.489)	0.001***
X_3 Specialization	-2301.962(-1.735)	0.085	-0.015(-0.853)	0.395	-0.642(-2.153)	0.033**
X_4 Root Output	9.7560(3.612)	0.000***	0.001(3.071)	0.003***	0.844(4.351)	0.000***
X_5 Root Price	0.732(1.658)	0.465	0.002(4.198)	0.000**	0.076(4.214)	0.000***
X_6 Input Prices	-0.204(-2.516)	0.002***	-2.877x10^6(-1.725)	0.087*	-0.002(-0.011)	0.000***
X_7 Government Payments	1.130(1.235)	0.219	4.385x10^6(0.993)	0.323	0.051(1.057)	0.292
X_8 Age	1556.570(3.811)	0.000***	0.006(1.617)	0.109	0.537(1.319)	0.189
X_9 Off-farm Income	-0.040(-0.068)	0.946	-7.962x10(-0.699)	0.486	-0.006(-0.549)	0.584
X_{10} Presenceof Succesor	1292.463(0.184)	0.854	-0.001(-0.010)	0.992	0.057(1.311)	0.192
X_{11} Education	457.079(0.560)	0.576	-0.008(-0.787)	0.433	-0.027(-1.025)	0.307
Model Fitness Parameters						
R^2	0.369		0.582		0.622	
Adjusted R^2	0.320		0.521		0.583	
Std Error	33199.744		41171.34		0.371	
F-Stat	4.669		3.406		3.978	
Prob.	0.000***		0.000***		0.000***	

Source: Computed from field survey data (2016)
***Sig. At P≤0.01; **Sig. at P≤0.05; *Sig. at P≤0.10. Figures in parentheses are t-test statistics. Accepted Model is double log regression.

The coefficients of volume of savings, root output, owned land and root price are positive and are statistically significant at 1% level of probability indicating that 1% increase in volume of savings, root output, owned land and root price will increase OFSP root farm investment by 0.092%, 0.844%, 0.185% and 0.076% respectively. Variables with negative coefficients indicate negative influence on investment behaviour in OFSP root production. The coefficient for specialisation was negatively assigned. This suggests that an OFSP root entrepreneur tends to invest more in diversified farm business to avoid total failure. This behaviour is understandable in view of the uncertainty surrounding agriculture in Nigeria. This result is consistent with Minot *et al*., (2006) and Ibrahim *et al*., (2009) who separately asserted that as farmers switch from subsistence food production to commercial agriculture, crop diversification will typically increase. The accepted double log multiple regression model is well behaved. The R^2 coefficient is 0.622 and the R square adjusted is 0.583. This implies that 58% variation in OFSP root investment behaviour is explained by the independent variables included in the regression model. The F-statistics is 3.978 and statistically significant at 1% probability level indicating the overall significance of the accepted regression model.

Conclusion

This study examined the determinants of investment behaviour among orange-fleshed sweetpotato root entrepreneurs in North Central, Nigeria. It is concluded that volume of savings; OFSP root output, owned land, and root price are major determinants of OFSP root production in the study area. The policy implication is that effort aimed at increasing the savings of the entrepreneurs, increase in OFSP root output, access to land and increase in output price could increase investment in OFSP root production in the study area.

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Performance and Cost-Benefit Analysis of Broiler Chickens Fed Doum Palm (*Hyphaene Thebaica*) Seed Meal Based Diet

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Abstract
The performance and cost- benefit of raising broiler chickens using Hyphaene thebaica seed meal (HTSM) diets was experimented; the process lasted for 56 days. Five experimental diets were formulated to meet nutrient requirement standards of broilers (NRC, 1994). Diet 1(0 % HTSM) served as the control while diets 2,3,4 and 5 contained 5, 10, 15 and 20% HTSM respectively replacing maize in the diets of birds. A total of two hundred and twenty five (225) day-old broiler chicks were randomly allotted into five treatment groups with three replicates of fifteen birds each. Each group was assigned to the five experimental diets in completely randomized design (CRD). Throughout the experimental period, feed and water were provided ad libitum for all treatment groups. There were significant differences (P<0.05) in all the parameters measured except total feed intake (P>0.05). The final live weight and total body weight gain of birds fed 0, 5 and 10 % HTSM diets (1995.68-2100.02 g and 1895.63-1999.97 g) were significantly better (P<0.05) compared to those fed 15 and 20 % HTSM diets (1217.58-1500.03 g and 1117.55- 1399.98 g). Birds fed 5 %HTSM diet gave the highest revenue (₦ 1990.14) while the least revenue (₦ 1365.81) was obtained among birds fed 20 %HTSM diet. The best profit (benefit) was obtained from birds fed 10 %HTSM diet. The cost - benefit ratio was the highest (1.84) among birds fed 20 %HTSM diet and least (0.81) among birds fed 10 %HTSM diet. It was concluded that 10 %HTSM diet was better since the lower the cost - benefit ratio, the more economically effective the diet.

Key word: broiler, performance, Cost- Benefit, Hyphaene thebaica seed meal

Introduction
The ever-increasing cost of livestock feeds with the attendant increase in the cost of animal products such as meat, eggs and milk has necessitated that there is the need to explore the use of non-conventional feed ingredients in the feeding of domestic animal (1,2,3). Doum palm (*Hyphaene thebaica*) is an African palm tree, common in Upper Egypt, originally native to the Nile valley, bearing an edible fruit which is glubosequandrangular, about 6 x 5 cm with a shinny orange-brown to deep chestnutskin (epicarp). It belongs to the family *Arecaceae* commonly known as doum palm, Dum Nut or ginger bread tree. Research on the fruit pulp has shown that it contains nutritional trace minerals, proteins and fatty acids, particular the nutritionally essential linoleic acid (4). (5) reported that the mesocarp of Doum palm fruits contains 8.10 % ash, 0.95 %ether extract, 0.01 %protein, 89.25 %carbohydrate, 3655.9 Kcal/kg Metabolizable energy while (6)showed that the fruit pulp contains 4.91% proteins, 5.26% fat, 4.5% ash and 85.33%total carbohydrate. This study therefore aimed at evaluating the performance and cost benefits of broiler chickens fed*Hyphaene thebaica* seed meal based diet.

Materials and Methods
The research was carried out at the Poultry unit of the Teaching and Research Farm of the Department of Animal Science, Federal University, Gashua, Yobe State, Nigeria. It has an area of 772km^2 and Coordinates: 12°52′5″N 11°2′47″E. The hottest months are March and April with

temperature ranges of 38-43°C. In the rainy season, June-September, temperatures fall to 23-28°C, with rainfall of 500 to 1000mm (7).

Preparation of *Hyphaene thebaica*seed meal (HTSM)

The dried *Hythebaica* fruits were purchased from Gashua market, Yobe state, in the North Eastern part of Nigeria. The fruits were crushed with machine and the kernels were discarded. The mesocarps were then milled to particle sizes to pass through a 3mm sieve, using a hammer mill. Other feed ingredients such as maize, soyabean, wheat offal, maize bran etc were purchased from Gashua market.

Experimental Diets

The experiment was in two phases (starter and finisher), five diets were formulated to meet nutrient requirement standards of broilers (8). Diet 1(0 % HTSM) served as the control while diets 2,3,4 and 5 contained 5, 10, 15 and 20%HTSM respectively replacing maize in the diets of birds. The gross composition of the experimental diets and their analysed nutrient contents are presented in Table 1.

Experimental Birds and Design

A total of two hundred and twenty five (225) day-old broiler chicks were purchased from a reputable distributor. They were raised on commercial broiler starter diet for one week, after which they were randomly allotted into five treatment groups with three replicates of fifteen birds each. Each group was assigned to the five experimental diets in completely randomized design (CRD). Throughout the experimental period, feed and water were provided *ad libitum* for all treatment groups. This was accompanied by necessary prophylactic medication and vaccination. The experiment lasted for a total of 56 days.

Table 1: Gross Composition of the Experimental Diets

	Dietary levels of *Hyphaene thebaica*seed meal (%)									
	Starter diets					**Finisher diets**				
Ingredients, Kg	**0**	**5**	**10**	**15**	**20**	**0**	**5**	**10**	**15**	**20**
Maize	54.00	51.30	48.60	45.90	43.20	56.00	53.20	50.40	47.60	44.80
*HTSM	0.00	2.70	5.40	8.10	10.80	0.00	2.80	5.60	8.40	11.20
Soyabean meal	27.00	27.00	27.00	27.00	27.00	24.00	24.00	24.00	24.00	24.00
Maize offal	5.95	5.95	5.95	5.95	5.95	6.80	6.80	6.80	6.80	6.80
Palm kernel cake	6.00	6.00	6.00	6.00	6.00	5.00	5.00	5.00	5.00	5.00
Fish meal (48%)	2.00	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50	1.50
Limestone	0.50	0.50	0.50	0.50	0.50	0.65	0.65	0.65	0.65	0.65
Bone meal	2.50	2.50	2.50	2.50	2.50	3.00	3.00	3.00	3.00	3.00
Palm oil	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
L-Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
DL-Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
**Vit/Min Premix	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated analysis (%)										
Crude protein	22.57	22.26	22.35	22.51	22.09	20.04	20.12	20.17	20.08	20.14
Crude fibre	3.76	3.85	3.90	4.11	4.17	3.62	3.75	3.97	4.01	4.05
Energy (Kcal/Kg ME)	2887	2883	2880	2875	2872	3058	3046	3040	3038	3031
Ether extract	5.36	5.33	5.38	5.34	5.37	6.12	6.07	6.11	6.18	6.09
Available P.	0.57	0.58	0.55	0.56	0.54	0.62	0.68	0.64	0.66	0.60
Proximate analysis (%)										
Dry matter	88.24	88.67	87.91	88.34	87.89	89.02	90.15	89.50	88.67	90.00
Crude protein	22.57	21.34	22.09	23.00	22.61	20.04	20.41	20.02	20.11	20.19
Crude fibre	3.76	3.89	3.93	3.98	4.00	3.52	3.70	3.78	3.88	3.97
Ether extract	5.36	4.90	5.21	5.09	4.98	6.12	6.37	6.00	6.04	6.57
Ash	5.62	6.01	6.20	6.09	6.17	5.53	5.86	6.17	6.90	6.14
NFE	62.69	63.86	62.57	61.84	62.24	64.79	63.66	64.03	63.07	63.13

*HTSM=Hyphaene thebiaca seed meal **To provide the following per kilogram of feed: Vit. A, 10,000 iu, Vit. D3,2000 iu, Vit. E, 5iu; Vit.K, 2mg; Riboflavin, 4.20mg; Vit. B12, 0.01mg; Panthotenic acid, 5mg; Nicotnic acid, 20mg; Folic acid, 0.5mg; choline, 3mg; Mg, 56mg; Fe, 20mg; Cu, 10mg; Zn, 50mg; Co.125mg.NFE: Nitrogen Free Extract =100-(%CP+%CF+%EE+%Ash).

Data Collection

The cost/kg feed was obtained by adding the cost of procuring the various feed ingredients in a particular treatment and dividing with the total feed consumed. Cost of total feed consumed was calculated by multiplying total feed consumed in each treatment with the cost/kg feed. The cost/kg weight gain was obtained by multiplying the cost/kg feed with feed conversion ratio (feed : gain). The benefit or profit index was obtained as:

R - PC

Where:

R = Revenue

PC = Production cost.

The cost benefit ratio was obtained by dividing the cost of production by the benefit (profit).

Statistical Analysis

Data generated from the study were subjected to one-way analysis of variance (ANOVA) using SAS Software (9). Means were separated with Duncan multiple range test at 5% level of significance.

Results and Discussion

The results of the performance and economic analysis of broiler chickens fed HTSM diet is shown in Table 2. There were significant differences ($P<0.05$) in all the parameters measured except total feed intake ($P>0.05$). The final live weight and total body weight gain of birds fed 0, 5 and 10 % HTSM diets were significantly better ($P<0.05$) compared to those fed 15 and 20 % HTSM diets. The total cost per kg feed decreased with increasing levels of HTSM in the diets due to the cheaper cost of *Hyphaene thebaica* seed (₦ 55.81/kg) compared to maize (₦120.00/kg) which is the dietary component replaced by HTSM in the diets. The cost of feed/kg weight gain was least for birds fed 15 %HTSM diet (₦381.79) while those on control had the highest cost (a difference of up to ₦45.69).Birds fed 5 %HTSM diet gave the highest revenue (₦1990.14) while the least revenue (₦1365.81) was obtained among birds fed 20 %HTSM diet. The best profit (benefit) was obtained from birds fed 10 %HTSM diet. The cost benefit ratio which is the ratio of the cost of the production expressed in monetary term relative to its benefits also expressed in monetary term was highest (1.84) among birds fed 20 %HTSM diet and least (0.81) among birds fed 10 %HTSM diet. This indicates that 10 %HTSM diet was better for the study since the lower the cost benefit ratio, the more economically effective the diet.

Table 2: Effects of Different Dietary Levels of HTSM on Performance andEconomic benefit of Broiler chickens (0-8weeks)

	Dietary levels of *Hyphaene thebaica* seed meal (%)					
Parameters	**0%**	**5%**	**10%**	**15%**	**20%**	**SEM**
Final live weight (g)	2100.02^{a}	2041.95^{a}	1995.68^{a}	1500.03^{b}	1217.58^{c}	121.61
Total body weight gain (g)	1999.97^{a}	1941.93^{a}	1895.63^{a}	1399.98^{b}	1117.55^{c}	120.03
Total feed intake (g)	6247.36	5946.08	6190.24	5986.96	6076.00	159.60
Cost/kg feed (₦)	119.54^{a}	116.45^{b}	114.61^{c}	111.02^{d}	108.48^{d}	0.39
Cost/kg weight gain (₦)	427.48^{a}	421.30^{a}	408.27^{ab}	381.79^{c}	400.01^{b}	8.54
Production Cost (₦)	918.55^{a}	912.30^{a}	891.33^{ab}	895.08^{ab}	885.51^{b}	10.47
Revenue (₦)	1977.05^{a}	1990.14^{a}	1988.38^{a}	1681.02^{b}	1365.81^{c}	15.78
Benefit (Profit) (₦)	1058.50^{a}	1077.84^{a}	1097.05^{a}	785.94^{b}	480.30^{c}	62.09
Cost benefit ratio	0.87^{a}	0.85^{a}	0.81^{a}	1.14^{b}	1.84^{c}	0.21

abc= mean with different superscripts on the same row are significantly different ($P<0.05$), SEM= Standard error of mean, P = Probability value. Cost of production = Cost of feed + Cost of medication + Cost of day old chicks. Revenue based on ₦950 /kg live weight. USD1=₦360

Conclusion

It was concluded that up to 10 % raw HTSM diet was economical and can be included in broiler diet as replacement for maize.

Acknowledgment

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Impact of Melon Cakes Sales On The Livelihood Of Women Farmers In Isuikwuato Local Government Area, Abia State

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Abstract
The study was conducted to examine the socio-economic characteristics of farmers involved in the melon cakes processing and marketing, compare difference between their incomes before and after embarking on the melon cakes processing venture The analytical technique adopted in achieving the objective of the study was the descriptive statistics (percentages, mean and frequency) and Paired Samples Test. The result showed that 43.3% were within the age range of 31 - 40 years. The study revealed that the mean income of the respondents after the processing of melon cakes business was ₦63,602.31, while their income before they started the traditional melon cakes value addition business was ₦21,200.00, with a difference of ₦42,402.31. This implies that the incomes of the women melon cakes producers were higher than their incomes before they embarked on the business. Therefore, it is recommended that melon farmers should be encouraged to form cooperative societies in order to facilitate easy access to agricultural information and benefit from agricultural programmes of the government

Keywords impact, Melon cake, Livelihood and farmers.

Introduction
The Traditional Egusi cake popularly known as "AhuIsu" in Ahaba-Imenyi, Isuikwuato Local Government Area of Abia State, is taken as alternative for meat. It is revenue yielding and enhances foreign exchange earnings in Nigeria. Melon (Egusi) is widely produced in West Africa with Nigeria accounting for about 65% of total production. The areas of high melon seed production in Nigeria include, Enugu, Abia, Benue, Nasarawa, Taraba, Kogi State. Melon seed (Colocynths citrulluslanatus) is rich in vitamins: fat, protein, vitamin B6 etc.The soft light yellow husks can be eaten together with the seeds, especially when mixed with African oil bean (Ugbaa). Melon is used as cover crop in farming; hence it reduces labour cost for weeding (Udealor, 2010). The melon seed can be manually or mechanically peeled or removed (Oti, 2012). The melon seed is ground as a flour and used in making soup "Egusi soup". It can also be processes into Traditional melon cake (Ojieh,2007). Also, the molded small melon cakes (akpuruakpu egusi) used in making soup can be eaten in place of meat. Melon contains protein 23.4% comparable to other plant proteins such as soya bean, cowpea and pumpkin etc (Amos, 2009). Melon seed can be processed to extract the oil content in it. The oil can be used as a vegetable oil. The fat content is 45.7% comparable to pumpkin seed oil. It contains 62.8% fatty acid which human body needs for healthy functioning, and which cannot be obtained from other food crops, except through food supplements. Human body needs this kind of fat (FAO. 2012). Melon fibre from both husk and seed stood at 12% which is high compared to other legumes. It contains up to 10.6% carbohydrate compared to other legumes. Also, it is rich in amino acid which human body needs for healthy living. Egusi is the richest in the mineral phosphorous potassium, magnesium, calcium and sodium (Aniedu, 2004). Women farmers in Ahaba Imenyi are majorly engaged in processing into melon seeds cakes. Only 20 (16.66%) are civil servants, the rest are either full-time farmers or combined farming with petty trading. Since the women farmers in the area depend largely on traditional agriculture for subsistence, any meaningful effort for their effective participation and improved living standards must be directed toward improving their production, processing and storage technology.

Processing melon seeds into cakes for sale is high income yielding and foreign exchange earnings. Therefore, there is urgent need to encourage women farmers and to bring them' to the limelight of sustainable agricultural development worthy of the new millennium. This research study therefore takes a critical on the extent of women participation in production, processing and sales of melon cakes for improved conditions/standards of living and poverty reduction in the study area.

Methodology

The study was conducted in Ahaba-Imenyi, Isuikwuato Local Government Area of Abia State.Isuikwuato is presently made up of three administrative units (Imenyi, Oguduassa and Isuamawo),.There are five major melon cakes processing communities among the five villages in Ahaba-Imenyi, Isuikwuato Local Government Area of Abia State namely: Amaogudu, Amaiyi, Ahaba-Ehuma, Ihe-Okwo and Ihenzu Villages. All the five communities were purposively selected; and data were collected by means of structured questionnaire. A total of 120 respondents were sampled. The list of melon cakes processing traders was obtained from the Agricultural Development Extension agent in the LGA. The analytical technique adopted in achieving the objective of the study was the descriptive statistics (percentages, mean and frequency) and Paired Sample Test.

Results and Discussion

Socio-Economic Status and General Living Standard (GlS) Of the Respondents before and after Processing and Sales Of Melon Cakes in The Study Area

The Socio-economic status and general living standard of the respondents were assessed under the following; age, education, occupation, family size, income, experience, marital status, membership of cooperative societies, type of housing, toilet facilities, source of drinking water and source of lighting. The results of the analysis for the socio-economic profile and Paired samples test incomes of the respondents (Before) and their incomes (After) sales of the melon cakes are presented in the Tables 1 and 2 respectively.

Age of respondents

The dominant age range was 46-55 years, which accounted for 33% and 36% before and after the sales respectively. The implication is that majority of the respondents belong to the middle-aged group that are known for their physical ability, productiveness, mental alertness and effectiveness more than older farmers (Amos,, 2009).

Table 1. Socio-economic Characteristics of the Respondents
Variables Respondents Gen. Living Std. Respondents (General Living Standard)

(Age)	After Melon Cakes Sales		Before Melon Cakes Sales)	
Variables	Frequency	Percentage	Frequency	Percentage
Year			(n = 120)	
26-35	23	19.00	20	17.00
36-45	32	27.00*	30	25.00*
46-55	42	36.00*	40	33.00*
56-65	23	19.00	30	25.00
Occupation				
Full time farming	70	58.00*	56	53.00
Part time farming	50	42.00	64	47.00
Marital Status				
Married	106	88.00	102	85.00*
Single	14	12.00	18	15.00
Education (years)				
No. Formal Education	24	20.00	42	35.00
Primary Education	25	21.00	20	17.00
Secondary Education	44	36.00	40	33.00*
Tertiary Education	27	23.00	18	15.00*
Income (Naira)				
100,000 – 290,999	32	27.00	40	33.00
300,000 – 490,999	36	30.00	30	25.00
500,000 – 690,999	52	43.00*	50	42.00*
Household Size				
1 – 4	16	13.00	10	8.00*
5 – 8	32	27.00	44	38.00
9 – 12	72	60.00	66	54.00*
Membership of Cooperative				
None	70	58.00*	38	32.00*
Cooperative Group	50	42.00*	82	68.00

Source: Field Survey, 2018

Occupation
On occupation, about 53% and 58% of the trainees before and after the melon cakes processing business respectively.58% were full-time farmers while their counterparts part-time farmers represented 42% (before the business) and 47% (after the business) of the sampled respondents. This explains why the full-time farmers tend to be less amenable to income diversification than their part-time counterparts.

Marital status
88% of the respondents are married. This implied that majority of the married women dominated this group. This is in line with the proposition that women play vital role in food production, processing and marketing n Nigeria (Asumugha, 2012).

Education
Also, the result showed that 33% and 36% of the respondents had secondary education, while 15% and 23% had tertiary education, before and after the sales respectively. The number of respondents who had primary education increased from 17% to 21%. According to Okoye *et al* (2008), educated farmers are more receptive to changes while farmers with little or no education are conservative to accept changes and innovations. The percentage of respondents with non-formal education (35% and 20%) confirms their perception.

Income
Table 1 showed that about 33% and 27% of the respondents between the family size of 1 – 4 persons fell within the income range of ₦10,000 - ₦29,999 per trading period before and after the melon cakes processing venture respectively. The respondents between the family size of 5 – 8 persons recorded 25% (before) and 30% (after), fell within the incomes range of N30,000 –

N49,999. The incomes of the pre-dominant family size of 9 – 12 persons ranged between N50,000 – N69,999 which recorded 42% and 43% respectively

Household size

Household Size of the respondents before and after the melon cakes processing venture were 8% and 13% respectively for persons between the age range of 1 – 4 years; 38% (after), and 27% (before) for 5 – 8 years respondents; and 60% (after), and 54% (before) for the respondents aged 9 – 12 years per family. The dominant class was 9 - 12 persons per family of the respondents. Although a priori expectation is in favour of increased profitability of larger families in the adoption of innovation, the cost of adoption is another issue to be considered. This is in line with the perception of Sabo (2006) who posited that large family size necessitated respondents to diversify their businesses for increased returns, to sustain their families.

Membership of cooperatives

From Table 1 about 42% of the respondents belonged to Cooperative Groups, before the melon cakes business, whereas the percentage increased to 58% after the trading period. This indicates that out of 58% women melon cakes-cooperators, only 32% of them belonged to none. The difference in the two classes of respondents implies that membership of cooperatives enhanced participation in the processing of into melon cakes. This is in support of Aniedu (2004) who opined that cooperative membership enhances participation and access to information on government agricultural programmes.

Table 2 showed that the mean income of the respondents after the processing of melon cakes business was ₦63,602.31, while their income before they started the traditional melon cakes value addition business was ₦21,200.00, with a difference of ₦42,402.31. This shows that the incomes of the respondents after the sales (trading period) are higher than their incomes before they started the processing of melon cakes business. It could be inferred that the sale of melon cakes business impacted positively on the incomes of the respondents.

Table 2: Paired samples test incomes of respondents (Before) and incomes of the respondents (After). (n = 120)

Variables	Mean	Paired Mean	95% Confidence Interval of the Difference	
			Lower	Upper
Respondents' Income After their Trading period	63,602.31*	42,402.31*	9,771.02	15,941.64
Income Before their Trading period	21,200.00*			

*P ≤ 0.05 Source: Computed from field survey (2018)

Conclusion

The study revealed that the mean income of the respondents after the processing of melon cakes business was ₦63,602.31, while their income before they started the traditional melon cakes value addition business was ₦21,200.00, with a difference of ₦42,402.31. This implies that the incomes of the women melon cakes producers were higher than their incomes before they embarked on the business. Therefore, it is recommended that melon farmers should be encouraged to form cooperative societies in order to facilitate easy access to agricultural information and benefit from agricultural programmes of the government.

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Socio-Economic Determinants of FADAMA III Rice Production Programme among Small Holder Farmers in Edo North Agricultural Zone, Edo State, Nigeria.

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Abstract
The study examined socio-economic determinants of fadama III rice production programme among small household farmers in Edo North agricultural zone of Edo State, Nigeria. It determined the effect of participating in the programme and examined the socio-economic determinants of respondents. TwoLGAswere randomly selected for the study. Ninety-three participants and non-participants farmers were randomly selected and used for the study. Data were analyzed using descriptive and inferential statistics. Results of T – test analysis showed that the average income of farmers participants and non-farmers participants in fadama III programme was ₦305,913.87 and ₦219,892.47 respectively. The study therefore recommended that government should ensure equitable and timely distribution of farm inputs among the farmers and more rice farmers should be brought into the scheme so that more persons standard of living can be improved.
Keywords: rice, production, participation, production, farmers, projects, determinants

Introduction
Rice (Oryza sativa) is one of the world's most important cereals, serving as a staple food for the population of most countries, including Nigeria (Okwuokenye and Onemolease, 2010). In an attempt to revamp the declining trend of rice production the then President Obasanjo's administration thought otherwise by encouraging local production through federal government policies like supply of improved inputs and subsidy on basic farm inputs, special rice programme, the Presidential initiatives on rice, cassava, livestock, etc. and most recently, the Fadama III programme that supports rice production. Report of Fadama III Rural Agricultural Projects (2010) defined fadama as flood plains and low land areas underlined by shallow aquifers and found along Nigeria's rivers. The report also stated that the scheme operates through small scale community owned infrastructure. This suggests the fact that smallholder farmers are the main or foremost thrust of fadama III programme. No work seemed to have been carried out in particular in the study area, hence this study is important and timely. In achieving this goal, the study examined the socio-economic characteristics of the fadama III small household farmers engaged in rice production in study area, identified the inputs provided to the farmers by the programme and examined the effects of respondents participation in the programme on farm income level.
The hypotheses were stated in their null forms. They are;
H_{o1}: There is no significant difference in farm income of small household rice farmers' participants and non-participants of fadama III programme

Materials and Methods
The study was carried out in Edo State, it has 18 LGAs with the capital seat at Benin City. The state is characterized by rainy and dry seasons with an annual rainfall of 2,500 mm and 1,500 mm in the Coastal areas and extreme North respectively (NAEC, 2008). The study was carried out in Edo North senatorial zone of Edo State. Two (Etsako East and Etsako West) out of five (5) LGAs where fadama is practiced were randomly selected for the study. From the LGAs Agenebode and Agbede were respectively selected for the study. Fifty (50) small household rice farmers were then

randomly selected from the fadama communities. This brought the total number of respondents administered with the research instruments to one hundred (100). Ninety-three (93) of the retrieved instruments suitable for analysis were then used for the study. An equivalent number of non-participants of the programme were also randomly sampled per community for comparative purpose.Data were sourced directly from the respondents by means of validated questionnaire instruments Data were analyzed using descriptive(frequency table, percentage and mean) and inferential statistics (t – test).

T – test was used to analyze hypothesis two. The formula for t- test is as shown below:

$$T = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{(s_1^2/n_1 + s_2^2/n_2)}} \qquad df = n_1 + n_2 - 2 \text{ ; (Madukwe, 2004)}$$

Where:

$\bar{x}_1$ = the mean of group 1;

$\bar{x}_2$ = the mean of group 2

S_1 = standard deviation for group 1; S_2 = standard deviation for group 2

S_1^2 = variance of the first group; S_2^2 = variance of the second group

n_1 = size of the first group; n_2 = size of the second group; √ = square root

Decision rule for t – statistics: if $t_{cal} > t_{tab}$ = reject null and accept alternative hypothesis; vice versa

Results and Discussion

The socio-economic characteristics of the respondents are shown in Table 1.It revealed that majority (72%) of the farmers were males while few (28%) were females. Findings of Aghanenu and Onemolease (2012) support this result. The average age of the respondents was 43.4 years and majority (39.78%) fell into the age bracket (40 – 49 years). The result indicates that the respondents were young and active. The result is in consonance with that of Fakoya and Daramola (2008).In educational level, most of the respondents (77.42%) had formal education and so could be described as literates with majority (40.86%) having a minimum level of primary school education. Similar result regarding low educational level was reported by Obasi (2005). Most (68.82%) of the respondents were married implying they were responsible. Aghanenu and Onemolease (2012) supported the dominance of married farmers in fadama programme. The average household size of the respondents was 9 persons and majority (35.48%) of them belonged to this group (7 – 9 persons). Most of the farmers (50.54%) have farm size of 2.1 – 4.0 ha. The mean was 3.10 ha. The result indicated that the respondents are small household farmers and it is in line with the result of Mgbada (2006).Farm experience of the respondents revealed that majority (46.24%) had 10 – 14 years rice farming experience. The average farm experience was 12.42 years. The result indicated that the farmers are well experienced in rice farming. The result of Aghanenu and Onemolease (2012) was in consonance with this finding.

Table 1: Socio-economic Characteristics of Respondents. N = 93

Socioeconomic variables	Categories	Freq.	Percentage	Mean
Gender	Male	67	72.04	
	Female	26	27.96	
Age	< 30	11	11.83	
	30 – 39	23	24.73	
	40 – 49	37	39.78	
	50 – 59	14	15.05	
	60 and above	8	8.60	43.39
Educational level	No formal educ.	21	22.58	
	Pri. sch.	38	40.86	
	Sec. sch	26	27.96	
	Post sec. sch.	8	8.60	
Marital status	Single	19	20.43	
	Married	64	68.82	
	Widow(er)	10	10.75	
Household size	1 – 3	7	7.53	
	4 – 6	16	17.20	
	7 – 9	33	35.48	
	10 – 12	23	24.73	
	13 and above	14	15.05	8.7
Farm size (ha.)	< 2.1	23	24.73	
	2.1 – 4.0	47	50.54	
	4.1 – 6.0	14	15.05	
	6	9	9.68	3.10
Farm experience (yrs)	< 5	4	4.30	
	5 – 9	21	22.58	
	10 – 14	43	46.24	
	15 – 19	14	15.05	
	20 and above	11	11.83	12.42

Source: Field survey, 2017

Inputs Provided by Fadama III Programme in Rice Production

The inputs provided to the farmers under the scheme in rice production are showed in Table 2. They were provided in different quantities to different farmers. The most supplied input according to most (88.17%) of the respondents was fertilizer, followed by improved varieties of seeds (73.12%). Additionally, 65.59% and 60.22% of the respondents respectively indicated that herbicides and insecticides were provided. Other inputs though poorly provided include tube wells/boreholes, motorized pumps and construction of irrigation channels which 41.94%, 36.56% and 11.83% of them respectively indicated were provided by the scheme. The result showed that the fadama III programme provided many different inputs sufficient,but not well spread to make remarkable success to all the farmers in rice production.

Table 2: Inputs provided by Fadama III Programme

Inputs provided	Frequency	percentage
Construction of irrigation channels	11	11.83
Motorized pumps	39	41.94
Tube wells / boreholes	34	36.56
Improved varieties of seeds	68	73.12
Fertilizer	82	88.17
Herbicides	61	65.59
Insecticides	56	60.22

*Source: Field survey, 2017.*multiple Responses Recorded*

Income Range (₦,000) of Respondents

The annual rice farm income of the respondents revealed that most (33.33%) of the fadama III programme participants earned an income of between ₦200,000 – ₦299,000, while most

(35.48%)of the non-participants of the programme earned between ₦100,000 – ₦199,000(See Table 3). The average farm earnings of programme and non-programme participants were ₦305,913.78 and ₦219,982.47 respectively. The difference in their average farm income was ₦86,021.31 and this was in favour of the programme participants. The result suggests that farmers' participation in fadama III programme had indeed enhanced farmers' income. Taiye *et al*., (2006) agreed with this finding as they noted that participating in farmers' programme helps to enhance farmers' productivity and consequently their income.

Table 3: Comparative Analysis of Rice Income between Participants and Non-Participants of Fadama III Programme

Income-range	Fadama participants (n = 93)			Fadama non-participants (n = 93)		
(₦'000)	Freq.	Percentage	Mean	Freq.	Percentage	Mean
< 100	4	4.30	₦305,913.78	14	15.05	₦219.892.47
100 – 199	14	17.20		33	35.48	
200 – 299	29	33.33		21	22.58	
300 – 399	25	24.73		19	20.43	
400 – 499	14	12.90		4	4.30	
500 & above	7	7.53		2	2.15	

Source: Field Survey, 2017; Difference in income between the groups = ₦86.021.31

Test of Difference in Income of Farmers and Non-Farmers of Fadama III Rice Programme

The results in Table 5 showed that the average income of farmers participants in fadama III programme was higher (₦305,913.87) than that of non-farmers participants (₦219,892.47). The difference between the two categories of farmers was ₦86,021.31 and this was significant at the 5% level. Based on the result, the alternative hypothesis was accepted. The result thus confirms the positive impact of fadamaIII programme. Findings of Taiye *et al.,* (2006) agreed with this finding. They acknowledged that participating in agricultural programmes helps to enhance farmers' productivity and income.

Table 4: Effect of Farmers' Participation in FADAMA III Rice Production on Income Level of Respondents (t - test)

FADAMA III Membership Status	N	Mean Income ₦	Difference (₦)	t - value
Farmers FADAMA III members	93	305,913.87	86,021.31	29.312*
Non-farmers FADAMA III members	93	219,892.47		

**Significant at the 5% level (Critical t – value = 1.289)*

Conclusion

Findings o the study concludes that participating in fadama III programme in rice production has positively influenced the farmers' income. The average farm income of programme participants was ₦305,913.87, while that of the non-participants was ₦219,892.47. The difference of ₦86,021.31 was in favour of the former, thus confirms its positive impact. From the findings of the study the following were recommended;The farmers noted that the inputs provided by the programme were not uniformly distributed. On this note, government should try to ensure an equitable distribution of farm inputs. This will help to increase farmers' productivity, and since there was a huge difference between participants and non-participants of the fadama III, it is therefore recommended that more rice farmers should be brought or allowed into the scheme so that more persons standard of living can be improved.

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Analyzing Levels of Market Orientation among Cassava, Yam and Cocoyam producers in Abia State, Nigeria

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Abstract
Rural farming households in Nigeria have a long tradition of producing primarily for home consumption and they only rely on the markets for the foods they cannot produce on their farms. However, due to changing economic trends, particularly in the face of rising poverty among rural households, the pattern of household production was such that most of the rural household productions are sold to the market for income in order to meet the financial obligations of the households. This paper examines the level of household reliance on some market purchased root and tuber crops to sustain the farm family food needs in Nigeria. Primary data collected from 96 households randomly selected from 4 villages were analysed using a simple descriptive statistics. The study revealed that, the mean quantity sold for cassava (≈744kg) was the highest followed by the quantity consumed (≈286kg). However, Cassava and yam (76%) ranked highest in the percentage distribution of farmers, based on the type of root and tuber crop produced in Abia State. Therefore, the study concludes that there is a high level of market orientation of cassava and yam only by the rural households and it varies significantly across poverty levels in the study area.
Keywords: Levels, Market orientation, Producers, Nigeria

Introduction
Understanding the changes in the share of food consumed by the rural farming households that is from the market in the face of changing socio-economic environment in which they operate is very important for several reasons (Onubuogu and Onyeneke, 2012) . It, for instance enables us to see how the rural farming households, who have hitherto in the previous year's been able to meet substantial parts of their home consumptions of food from own production and how much of own food produced offered to the market have been affected by the changing social, economic and political environments in the country (Hernandex *et al*., 2007). Looking across poverty levels is also desirable so as to see the effect of household poverty on the degree of market orientation of both the poor and non-poor households (Weatherspoon and Reardon, 2003).This paper is another effort in food demand studies with a view to understanding the level of market orientation of rural households and also to determine the appropriate points of policy intervention in food supply programmes. Furthermore, the role of markets in poverty and food intervention programmes needs to be better understood in the country in the face of changing socio-economic factors such as population, personal income levels, rapid rate of urbanization and tastes. Therefore, there is need for an assessment of the household food demand in the context of the role of the rural markets with a view to providing the empirical evidence required to understand the issues involved in designing an appropriate mix of policies for national and regional food and market planning (McCullough *et. al*., 2008). There are comparatively few published articles that have addressed the level of market orientation of cassava, yam and cocoyam producers in Nigeria. The study attempted to analyze the level of market orientation of some selected food crops.

Methodology
A purposive sampling technique was used in selecting a state and respondents. Abia state was chosen based on Cassava, Yam and Cocoyam production. Two local government areas was selected,

four communities, four villages was also selected, finally, twelve cassava, yam and cocoyam farmers were selected based on the number of registered farmers in that area, making it a total of 96 farmers. However, these respondents comprised of producers, processors and marketers. Information were elicited from the respondents by means of focused group discussion, interview schedule and structured questionnaires. Data were analyzed using descriptive statistics, means and percentages.

Results and Discussion

Socioeconomic Characteristics of the Respondents

The result in table 1 pointed out that 85% of the respondents were within the age range of 35-44 years with a mean age of 40 years. This implies that majority of the respondents were young and are ready to accept innovations, this in line with Poison and Spencer (1991). Dominance of female (54%) as against 45% male, suggests that root and tuber crop production is gender sensitive and requires more women than men, this is in agreement with Anyiro *et al* (2013). Also majority (90.6%) of the respondents were married also acquired basic education. This result is in line with the findings of Onubuogu and Onyeneke, (2012) who posited that education and training enhances farmers' productivity and market oriented production objective .Household size between 5-10 persons had 84.3% with the mean household size of 6 persons. The large household size is attributed to the need for cheap and dependable labour derivable for on-farm and off-farm activities. This finding is in agreement with the findings of Onubuogu *et al*, (2014) reported the most farm families have large household size between 5 to 10 persons with mean of 6 persons. Furthermore, 60.3% of the respondents fell within the monthly income level of ₦41,000 - ₦60,000, with mean income of ₦45,620. This shows that market orientation of cassava, yam and cocoyam can be found to be very lucrative as the income of the farmers are higher than normal.

Table 1.Socioeconomic characteristics of root and tuber crop producing households (n=96)

Variables	Frequencies	Percentage	Mean
Age			
25 – 34	1	1.0	
35 – 44	82	85.6	40
45 – 54	9	9.3	
55 and above	4	4.1	
Total	**96**	**100**	
Gender			
Male	44	45.8	
Female	52	54.2	
Total	**96**	**100**	
Marital status			
Single	9	9.4	
Married	87	90.6	
Total	**96**	**100**	
Educational Level			
Non-formal	0	0	
Primary	11	11.5	
Secondary	52	54.2	12
Tertiary	33	34.4	
Total	**96**	**100**	
Household size			
0 – 4	11	11.5	
5 – 10	81	84.3	**6**
11 and above	4	4.2	
Total	**96**	**100**	
Income			
1000 – 20000	14	14.7	12,620
21000 – 40000	14	14.5	
41000 – 60000	58	60.3	
61000 and above	10	10.5	
Total	**96**	**100**	
Total	**96**	**100**	

*Multiple Responses Recorded. Source: Field survey data, 2016

Levels of Market Orientation
Sampled respondents mentioned quantity of root and tuber crops sold in kg in the available markets. These were summarized and presented in Table 2.

Table 2: Mean Value of the Allocation of Household Root and tuber Crop Productions (n=96)

Type of Root and Tuber Crop	Quantity Sold (Kg)	Quantity Consumed (Kg)	Quantity given as gift (Kg)
Cassava	743.5417	285.5208	70.41667
Yam	142.5521	88.33333	30.72917
Cocoyam	19.07292	6.020833	2.927083

Source: Field Survey, 2016

The pattern of household production was such that most of the rural household productions are sold to the market for income in order to meet the financial obligations of the households. Thus in agreement with Ololade and Olagunju (2013) report which earlier posited that income enhances productivity and promotes standard of living by breaking vicious cycle of poverty of small scale farmers. Some of the root and tuber crop produced goes into home consumption while some households give their farm produce as gifts to friends and relatives. This is firmly rooted in the tradition of Africans that you have to be your brothers' keeper. Apart from gifts some other uses also occur in that category. According to Eke-Okoro (2011), root and tuber crops play significant roles in the food economy of Nigerians. The root and tuber crops sector provides job opportunities and generate income for Nigeria.

Output Size of Cassava, Yam and Cocoyam Production
Figure 1 shows the percentage distribution of farmers based on the type of root and tuber crop produced. From the result; planting cassava and cocoyam ranked lowest (4%), followed by Cassava only (20%) and the highest of them all is Cassava and yam (76%). Eke-Okoro (2011) also posited that the importance of cassava in the lives of many Nigerians cannot be over-emphasized.

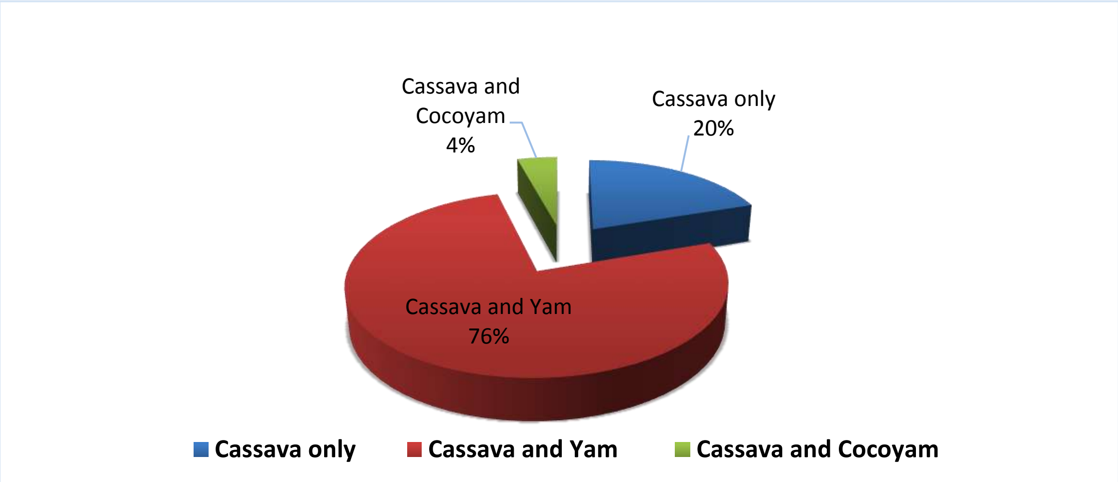

Figure 1: Percentage Distribution of farmers based on the type of root and tuber crop produced
Source: Survey Report, 2016

As food, it comes first among the root and tuber crops despite the respect yam commands as a ceremonial crop. He also mentioned that the advantages of cassava as a candidate crop for hunger alleviation, poverty eradication and food security include tolerance to drought, low demands on soil nutrients, and capacity for providing good root. While yam (*Dioscorea spp)* are major carbohydrate staple and provides food for over 60 million people in West Africa. The importance of yam in Nigeria and indeed throughout the West African yam belt is not only for its role as a major food staple but also its socio-cultural significance in the life of the people. Cocoyam (*Xanthosoma sp: Colocasia sp*) are also important staple in Nigeria ranking third among the root and tuber crops after cassava and yam. Nigeria is the world's largest producer of cocoyam and has an increased production output for more than 12 million tonnes. (NRCRI, 2000).

Conclusion

The study concludes that there is a high level of market orientation of cassava and yam only by the rural households and it varies significantly across poverty levels in the study area. Policies that would enhance the income generating activities of the rural households in the study area is desirable so as to enhance their food purchasing power, reduce food insecurity and reduce poverty relative to food. Furthermore, there should be an appropriate policy that would take care of the anticipated changes in the structure of food demand as poor households tends to become non-poor, when their income increase.

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Cassava Production in Kogi State, North Central Nigeria: A Review

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Abstract
Cassava production in Kogi State North Central Nigeria was purely subsistence about two decades ago but now it has assumed the status of a cash crop, providing food and incomes in a sustainable manner to millions of people in the State. Kogi State is one of the major producers of cassava in Nigeria with over 4.16million metric tonnes annually. Favourable climate, good soils, cassava-based farming system, available large-scale processors, donor supported projects and over dependence of the population on the crop as a major source of carbohydrate and enterprising farmers contributed in making Kogi State the highest producer of cassava in Nigeria. The cassava value chain in the State has been able to meet the challenges of the nation through job creation, wealth generation and industrialization. A two-year cycle of cassava fresh root glut has been a major problem facing producers which could be reduced through increased diversification of processing options, expanded markets and informed end users. For the State to remain relevant in the cassava industry there is the need to increase area cropped and yield per hectare, more emphasis on production for industrial use and be less dependence on cassava for food.
Keywords: Cassava, Production and Kogi State

Introduction
Cassava (M*anihotesculenta, C*rantz) is a versatile crop that is critical for food security in Africa, Asia and Latin America. Millions of smallholder producers rely on cassava for their subsistence especially during lean season. Globally, the largest producer of cassava in the world is Nigeria followed by Brazil, Thailand, Zaire and Indonesia (FMARD, 1999). In Nigeria, cassava is one of the most important crops. It is the most widely cultivated crop in the central and southern parts of the country in terms of area devoted to it and number of farmers growing it. Cassava has also increased in importance in the Middle Belt in recent years. It is fast replacing yam and other traditional staples within the production belts. The major food products from cassava in Nigeria are gari (creamy-white, partially gelatinized, roasted, free flowing granular flour with a slightly fermented flavour and sour taste), fermented flour, unfermented flour (sundried cassava chips milled in the form of flour) and akpu (fermented wet paste) (PIND,2011). The high industrial and market potentials of cassava have attracted private sector interests. For instance, in Cote d'Ivoire and Nigeria, Nestle is now using cassava starch rather than maize starch in its manufactured culinary broths. This multinational company is supporting producers, providing them with improved cassava varieties and buying their roots. Brewers are also focussing on brewing cheaper beers using locally grown crops as substitute for imported barley. Those in the biofuel technology are not left out in the use of cassava for the production of cheap biofuel. In the ceramics industry, it is used as a binder.

Strength of Kogi State in cassava production
The strength of Kogi State in cassava production and utilization lies with its natural endowment with a people that depends on cassava for their survival and sustenance. Kogi State was created out of former Benue and Kwara states along with eight others on 27th August, 1991. The State is located within the equator and thus spans the tropical rain forest on the southern fringes and the woody derived savannah and Guinea savannah in the northern extreme. There are approximately 228,964 farm families in Kogi State (Kogi ADP,1997).Rainfall pattern in Kogi State is generally adequate with enough sunshine which are ideal for most agricultural crop production.Generally,

the soils of Kogi State consist of ferruginous tropical soils, forest soils, which are rich in humus and moderately acidic with low organic matter content. Alluvial soils abound along the Niger and Benue valley and their flood plains.The cultivation of food crops such as rice, yam, cassava, sorghum, maize, millet, cowpea and groundnut prevail the agricultural practice, while mixed cropping is the common farming system.. Cassava based mixtures are most common in the farming system. Average farm size is between 2-3ha per farm family with average family size of 6-7 persons. Cassava is widely grown in all the LGAs of the state. Indeed, it is grown by almost every household (RTEP 1997)

Opportunities for cassava production in Kogi State
Kogi State is one of the major producers of cassava in Nigeria. It produces over 4.16million metric tonnes of fresh cassava roots annually from over 269,270 hectares of cassava farms (Kogi ADP 2014).The major production outputs are from Ankpa, Dekina, Kabba-Bunu, Ijumu LGAs. Before the cassava production revolution of the early part of this millennium, cassava was utilized mainly as food in the State leaving little for industrial uses most of which were rudimentary and rural based. The little starch produced was for local laundry services. There were 134,635 cassava farms in Kogi State on an area of 269,270 hectares (Table 1). Average yield per hectare was 12 tonnes which was the national average.

Table1: Cassava Production and Utilization in Kogi State

Statistics	**Nigeria**
Production (mmt)	45,721,000
Cassava area (ha)	381,0000
Yield (t/ha)	12.0
Cassava farms (No)	4,520,000
Cassava rank as food	1
Statistics	**Kogi State**
Production (mmt)	4,000,000
Cassava area (ha)	269,270
Yield (t/ha)	12.0
Cassava farms (No)	134,635
Cassava rank as food	1

Source: Cassava Statistical year book,2004

Status of cassava production in Kogi State
Kogi State is the largest producer of fresh cassava roots in Nigeria (NFRA, 2008). It produced over 4.16million metric tonnes annually (Table 2). Starting from1994, when the first Crop Area Yield Survey (CAYS) was conducted, cassava production in the State was 1.227mmt from an area of 121,260 hectares with a yield of 10.12t/ha. Production of cassava continued to increase in Kogi State to 2.794mmt in 1999 from an area of 182,790ha and a per hectare yield of 15.28tonnes. This improved performance was due mainly to the funding intervention of the Cassava Multiplication Project (CMP) which was inherited from Benue State after the States creation exercise of 1991. The CMP came to a technical close in 1998.Expectedly, cassava production declined in year 2000 (2.506mmt) and yield per hectare also reduced (13.47t/ha) (Table 2). From 2003 to 2011, production of cassava in Kogi State again improved with an all high figure of 5.032mmt and a yield per hectare of 19.32 (Kogi ADP, 2017). This feat could be attributed to the funding intervention by the Root and Tuber Expansion Programme (RTEP) of the Federal Government of Nigeria (FGN) supported by the International Fund for Agricultural Development (IFAD).
Following this improved production, the problem of glut emerged in the cassava supply chain. The challenge was how to encourage producers to continue production at a profit. Cassava producers were seriously experiencing glut which was cyclic in nature; a two year cycle of cassava fresh root glut followed by two year scarcity. The main task of the ADP was to ensure the availability of planting materials every year in order to sustain production and reduce the cassava glut.

Table 2: Cassava production in Kogi State (1994 - 2017)

Year	Production ('000)	Area cultivated ('000)	Yield/ha
1994	1227.90	121.26	10.12
1995	1635.16	128.19	12.75
1996	1858.28	145.64	12.75
1997	2319.21	178.69	12.97
1998	2771.38	183.17	15.13
1999	2794.32	182.79	15.28
2000	2506.00	186.00	13.47
2001	2704.00	177.90	15.19
2002	2785.12	177.90	15.65
2003	2854.85	173.20	16.48
2004	2969.63	175.24	16.94
2005	2666.41	180.75	14.75
2006	3394.71	214.18	15.84
2007	3631.94	243.96	14.88
2008	3741.90	252.84	14.79
2009	4011.26	269.27	14.89
2010	4396.34	289.96	15.16
2011	5462.79	282.61	19.32
2012	4094.36	290.34	14.10
2013	5032.93	294.65	17.08
2014	4131.16	221.77	18.62 *
2015	3048.98	198.77	15.34*
2016	4621.46	317.62	14.55*
2017	4806.62	283.07	16.98*

Source: APS, Kogi ADP (1994-2017),*Production figures from 2014 – 2017 were yet to be certified

Stimulation of processing to reduce cassava glut

The next hurdle was to reduce or eradicate the problem of glut experienced by producers every two years. The component of RTEP called Diversification of Processing Options and Products had to be implemented in detail in Kogi State. Recipes of cassava and end users were identified, staff of the Kogi ADP were trained and product demonstrations were conducted in all the zones and major locations in the State. Master bakers were trained to the use ten percent High Quality Cassava Flour (HQCF) as substitute for wheat. Model Cassava Processing Centreswere established across the RTEP participating Local Government Areas of Ankpa, Dekina, Igalamela/Odolu, Okehi, Yagba-West in addition to similar ones atIjumu and Lokoja. The establishment of these model processing centres was a major milestone in the quest to modernize cassava processing. This major intervention brought about improved processing capacity amongst processing groups arising from the use of modern processing equipment, enhanced product quality through training and better packaging. Production of cassava roots increased steadily due to availability of improved planting materials which were distributed to producers to support the supply of fresh roots to the existing processing centres. Local fabricators were trained and empowered to provide maintenance services to producers and processors.

Job creation in the cassava industry

The cassava value chain has great opportunities for job creation, wealth generation and industrialization. There are a number of enterprises within the cassava value chain that could boost the actualization of these three noble potentials. From field survey conducted among producers and processors, it was revealed that a hectare of cassava could gainfully employ a person for a year, while a 1.50 ton per day capacity gari factory could engage 75 people (Table 3). From the table below, gari processing factory was the highest employer of labour while cassava production employed the least number of persons.

Table 3: Employment generation by cassava-based enterprises in Kogi State

Type of enterprise	Capacity	No employable/yr (person)
Cassava production	1ha	1
Processing into gari	1.50 ton/day	75
Processing into cassava chips	1.50 ton/day	30
Processing into HQCF	1.50 ton/day	35
Processing into HQCF	5.00 ton/day	70

Source: Field observation

Apart from these core enterprises in the cassava value chain, there are a number of other ancillary service providers and chain actors that employed persons. These included transporters, tractor operators, spare parts dealers, agro-dealers, spray gang operators, food vendors etc.

Challenges of cassava production and utilization in Kogi State

The main challenges to production and utilization include the followings

- Poor rural infrastructure (bad rural roads and near absence of water in most rural areas)
- Drudgery in production and processing
- Limited land for mechanization
- Limited tractors and implements
- Adulterated agro-chemicals
- Weak and poorly manufactured sprayers
- Unstable market prices for fresh cassava roots
- High cost of cassava cuttings
- High transport cost

Envisaged level for cassava production and processing in Kogi State

For Kogi State to remain as a leader in cassava production, the State and other stakeholders in the industry should rededicate their efforts in achieving the underlisted targets.

- Increasing yield/ha to at least 35tons
- Increase State production to 40.00million metric tons
- Area cropped to cassava to increase to about 350,000ha
- Emphasis on production for industrial use (starch and feed)
- Less dependent as food

Recommendations to achieving the goals for cassava production in Kogi State

- There should be more land cleared for cassava production. This is a major constraint to production. In other to attract youths to join the revolution, the State should provide cleared and tractorable land.
- Sustained full mechanization of the entire production and processing value chains. Simple labour saving devices in both production and processing would greatly revolutionalize the cassava industry. This include tractors, planters, sprayers, peelers, packers/trucks, harvesters etc
- While small and medium scale producers and processors are encouraged to thrive, the State should provide enabling environment for private sector participation which is key for cassava revolution.
- Governments (State and Local Government Areas) should as a matter of necessity provide a favourable environment to doing business in the State. These include among others adequate security and rural infrastructures (rural roads, potable water supply and electricity).

Conclusion

Cassava production has come to stay in Kogi State as the crop is the main staple of most of the farm families of the State. To drastically reduce poverty and unemployment, government should intensify efforts to promote rural economy and enabling environment for entrepreneurial development through the provision of rural infrastructures especially roads and potable water. Private sector participation is key to the vision of the State.

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Influence of Socioeconomic Factors on Yam Production Output in Umuahia Agricultural Zone of Abia State, Nigeria

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Abstract
The study was carried out to assess influence of socioeconomic factors on yam production output in Umuahia Agricultural Zone of Abia State. Structured questionnaires were used to elicit information from the farmers. Multi-stage sampling method was used in data collection the study. One block from the zone was purposively chosen, because of her engagement in production of yam in the zone. Four circles were randomly selected and 30 farmers from each of the four circles were randomly selected for the study. In all 120 respondents were used as the sample size. List of farmers collected from the community head served as the sample frame. Data were analyzed using descriptive and inferential statistics. Result showed that majority of the respondents (55.8 %) were males,46.7% of the farmers who responded were between 41-50 years, greater percentage of the respondent (69.2%) were married andabout 48.3 % of the respondents had between 5 and 9 household members. The result of the regression analysis revealed that yam production output was influenced by some socio-economic factors such age, education, farm size and labour since these factors were significant at 10% and 1% levels. The study concluded that socioeconomic factors had much influence on yam production output in Umuahia Agricultural Zone and therefore, it is recommended that male farmers in the area should be encouraged to participate actively in yam production so as to increase the output of yam production since sex was significant but negatively related to yam production output in the study area.
Key words: Factors, Yam, Production and Output.

Introduction
Yam is one of the tuber crops produced in Nigeria and it has as many out of which six are economically important staple species. They are *Dioscorea rotundata* (white guinea yam), *Dioscorea alata* (yellow yam*), Dioscorea bulbifera* (aerial yam), *Dioscorea esculenta* (Chinese yam) and *Dioscorea dumetorum* (trifoliate yam). Out of these, *Dioscorea rotundata* (white yam) and *Dioscorea alata* (water yam) are the most common species found in Nigeria (Anozie *et al.,* 2014). Yams are grown in the coastal region in rain forest, woody savanna and southern savanna agro ecology.In many yam-producing area in Nigeria, it is said that "yam is food and food is yam" (Bolarinwa and Oladeji, 2009).Yam production in Nigeria has more than tripled over the past 45 years from 8.7 million tons in 1961 to 31.3 million tons in 2006. This increase in output is attributed more to the large area planted to yam than to increased productivity (Izekor and Olumese, 2010).Though the area cultivated to yam production is still being increased, production growth rate declined tremendously from average of 27.5% between 1986 and 1990 to 3.5% in the period between 1991 and 1999 (FAO, 2002). Yam crop forms a staple food for most people of the tropics. Yam tubers are eaten in different forms include eating it boiled, fried, pounded or made into yam powder for fufu. As food crop, the place of yam in the diet of Nigerians cannot be overemphasized. It contribute more than 200 dietary calories daily, for more than 150 million people in West Africa as well as serving as an important source of income (Babaleye, 2003).Yam also plays vital roles in traditional culture, rituals and religion as well as local commerce of African people (Izekor and Olumese, 2010). Due to the importance attached to yam, many communities in Nigeria celebrate the new yam festival annually (Ibitoye and Onimisi, 2013). Yam production has been on decrease in Umuahia agricultural zone of Abia state despite its numerous importance.

Hence, the study to determine the influence of socio-economic factors on yam production output in the study area. The objectives of the study are to describe the socio-economic factors influencing yam production

Methodology

The study was carried out in Umuahia Agricultural Zone of Abia State. Structured questionnaires were used to elicit information from the farmers. Multi- stage sampling technique was used in data collection. One block from the zone was purposively chosen, Ikwuano LGA, because of her level of engagement in yam production in the zone. Four circles were randomly selected and 30 farmers from each of the four circles were randomly selected for the study. In all 120 respondents were used as the sample size. Data were analyzed using descriptive statistics and inferential statistics such as frequency, percentages and multiple regression model. The model is implicitly stated as;

$Y= (X_1, X_2,\ldots\ldots X_6,X_7+u)$

Where

Y = Output (kg)

X_1 = Age (years)

X_2 = Sex (male or female)

X_3 = Education (number of years spent in school)

X_4 = Farming experience (years)

X_5 = labour (man-days)

X_6 =Farm size (hectare)

X_7 = Membership of association (member or non-member)

u = Error term

Results and Discussion

Results in Table 1 shows that majority of the farmers (46.7 %) fall between 41-50 years. This implies that yam production and its increase output requires able bodied men. This finding is in agreement with Waziri *et al.* (2014) who opined that majority of farmers within the age range of 41 to 50 years are still in their active age, more receptive to innovation, more technically efficient, effective and could withstand the stress and strain involved in yam production.

Table 1: Distribution of Respondents Socio- Economic Characteristics in the Study Area n = 120

Variables	Frequency	Percentage
Age		
20-30	2	1.7
31-40	33	27.5
41-50	56	46.6
51-60	15	12.5
61 and above	14	11.6
Sex		
Male	67	55.8
Female	53	44.2
Educational attainment		
Non-formal	4	3.3
Primary school	20	16.7
Secondary school	56	46.7
Tertiary education	40	33.3
Marital status		
Single	37	30.8
Married	83	69.2
House hold size		
1-4	17	14.2
5-9	58	48.3
10-14	32	26.7
15-19	13	10.8
Farming experience		
1-5	11	9.2
6-10	27	22.5
11-15	45	37.5
16-20	28	23.3
21 and above	9	7.5
Labour source		
Own labour	12	10.0
Family	35	29.2
Hired	25	20.8
Family and hired	48	40.0

Source: Field survey, 2016.

The result also shows that majority of the farmers constituting 96.7% possess formal education. Most of the farmers (55.8 %) were male while about (44.2 %) were female. Traditionally, it is believed that women in Igbo land are not meant to cultivate yam and it requires a lot of energy for its production. According to Ironkwe and Ewuziem (2010), traditionally yam is regarded as ‘‘Man's crop’’. Greater percentage of the respondents 69.2 % was married. Farming is a necessary condition for families to lift their households out of poverty and ensure hunger free situation in homes. This agrees with the findings of Augustine *et al.,* (2008) who found that over 70% of the married couples were involved in yam production in South Eastern Nigeria. Majority of the respondents (48.3%) have between 5 and 9 household members. Traditionally, yam production is a labour intensive enterprise, family size is a necessity for the size of the farm and increase in production of yam in the area (Nahanga and Vera, 2014). Table 1 also shows that 37.5% of the farmers had farming experience between 11-15 years while about 23.3% of the farmers had farming experience of between 16-20 years. Farming experience enable farmers to set realistic targets. This finding corroborates the finding of Ironkwe, *et al.,* (2007), that experience improves farmers' production skills such as good planting methods and the use of improved seeds.

Table 2. Multiple Regression Analysis of Socio-economic Factors Influencing Yam Production Output in Umuahia Agricultural Zone

Variable	Linear	Semi-log	Double –log	+Experiential
Constant	.361	-.301	11.528	1,770
	(2.443)**	(-.575)	(.395)	(1.660)*
Age	0.007	.053	.066	-.001
	(0.76)	(.562)	(.724)	(-.013)
Sex	-.145	-.139	-.178	-.177
	(-1.639)*	(-1.509)*	(2.044)*	(-2.108)*
Education	.120	.048	.099	.160
	(1.372)	(.527)	(1.148)	(1.921)*
Farming experience	.026	-.038	-.074	.003
	(.296)	(-.406)	(-.848)	(.036)
Labour	-.198	-.192	-.257	-.263
	(-2.285)**	(-.2.119)**	(-2.957)***	(-3.173)***
Farm size	.362	.259	.297	.378
	(4.031)***	(2.752)**	(3.412)***	(4.494)***
Membership of Association	-.086	-.117	-.097	-.056
	(-.959)	(-1.256)	(-1.080)	(-.649)
R^2	.449	.350	.454	.511
F-statistics	3.078***	1.707*	3.169***	4.316***

Source: Field Survey, 2016. Key: *** = significant at1% level, * = significant at 10% level. + Experiential

Result of Table 2 reveals the result of multiple regression of socio-economic factors influencing yam production output Among the four functional forms, the exponential form was selected as the lead equation because of a high R^2 (0.511) value, number of significant variables and appropriate a priori expectation. The R^2 indicated that 51%variability in yam production output was explained by the independent variables. F ratio was also highly significant at 1%, indicating goodness of fit. The results in table 2 depict that sex is significant at 10% but negatively related to yam production output in the study area. The result shows that female farmers were more in yam production in the study area and this will affect the output of yam since yam is labour intensive, more demanding in term of agricultural practices and regarded as man's crop. Educational attainment was found significant and positively related to yam production output at 10% level. The result implies that the more educated a farmer had, the more the farmer puts in necessary practices and techniques that can improve yam production output. Ume, *et al.* (2013), state that education helped to facilitate adoption as it makes one to be more objective in evaluating innovation, which will influence his or her production. The result also shows that labour source was significant but negatively related to yam production output. It means that the more labour requirement in the farm, the lesser production output. This could be as a result of misallocation or over utilization of labour (Anyaegbunam *et al*, 2016). Farm size was significant and positively related to yam production output at 1% level. This means that the larger the farm size, the more yam production output in the study area.

Conclusion

The study concluded that socio-economic factors such sex, age, education, farm size and labour influenced yam production output in Umuahia Agricultural Zone since these factors were significant. Therefore, it is recommended that male farmers in the study area should be engaged in yam production so as to increase the output of yam production, since sex was significant but negatively related to yam production output in the study area.

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Analysis of Cooperative Societies Credit Delivery in Umuahia North Local Government Area of Abia State, Nigeria.

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Abstract
The study examined cooperative society's credit delivery in Umuahia North Local Government Area of Abia State, Nigeria. The specific objectives include determining the criteria for selection of members and the status/trend of loan application and approval. A purposive sampling technique was used in selecting the sample used for the study. Data was collected with the aid of well-structured questionnaire and secondary data. Data were analyzed using descriptive statistical tools such as frequency distribution, means, percentages and Paired T-test. Eight cooperatives societies were purposively selected for study. The study showed that majority of the respondents in the zone agreed that cooperatives must adhere to the necessary criteria for selecting members; non-adherence to the stipulated conditions could lead to derailment of the cooperative aims and objectives. More so, the result showed that there was access to cooperative credit in Umuahia North, since the Average Approval Rate was 60.85%. An indication that farmers had good access to cooperative loan. The study therefore recommends that the funding of business enterprises among the cooperatives should be based on their mandates; this measure will ensure the sustainability of cooperative activities and quick realization of goals and objectives. Cooperatives should ensure speedy treatment of loan request, this will help reduce the idle time and facilitate greater outreach to clients.
Key words: Cooperative Societies, Credit, Delivery, Agriculture

Introduction
In most third world countries (Nigeria inclusive), agriculture dominates the nation's economy. It has been established that about 70 percent of Nigeria's population is engaged in agriculture (Obasi and Agu, 2000) while 90 percent of Nigeria's total food production comes from these small farms and 60 percent of the country's population earn their living from these small farms (Oluwatayo, Sekunmade and Adesoji 2008; Izekor and Alufohai, 2010 and Awotide, Aihonsu &Adekoya. 2011).). It is the cooperative that embraces all type of farmers and a well-organized and supportive cooperative is a pillar of strength for agriculture in Nigeria (Ijere, 1981;Izekor and Alufohai, 2010). Credit is considered as a catalyst that activates other factors of production and makes under-used capacities function for increased production (Ijere, 1998).Credit is defined as financial resources obtained at certain period of time with an obligation to repay at a subsequent period in accordance with the terms and condition of the credit obtained (Ijaiya and Abdulraheem, 2000; Awotide *et al*., 2011The informal source of credit is more popular among small scale farmers which may be due to the relative ease in obtaining credit devoid of administrative delay, non-existence of security or collateral, flexibility built into repayment which is against what is obtained in the formal sources, (Afolabi and Fagbero,1998 ;Izekor and Alufohai, 2010). Aryeetey (1997) noted that the informal rural financial sources in Africa perform better than the formal system because the institutional lending system has failed to meet the objective for which they were set up. Ojo(2005), observed that the institutional lending system has failed to meet the objective for which they were set up The cooperative societies have been identified to be a better channel of credit delivery to farmer in term of its ability to sustain the loan delivery function (Alufohai, 2006).It is against this backdrop that this study aimed to determine cooperative societies' effectiveness in credit delivery to agricultural and non-agricultural enterprises in Umuahia North Local Government Area of Abia State, Nigeria. The objectives of the study include to; determine the socio-economic characteristics

of cooperative societies in the study area, the type of agro-based enterprises funded and criteria for selecting members among the cooperative societies, the status/trend of loan application and approval, determine the effectiveness of credit delivery to agricultural and non-agricultural enterprises and determine the effect of cooperative society's credit on beneficiaries of agro-based enterprise growth. It is hypothesized that there is no significant difference among the growth parameters of selected agro-based enterprises production before and after cooperative credit in Umuahia North.

Methodology

North was purposively selected for the study due to high level of cooperative societies activities interaction of cooperative societies and the agricultural projects/ programmes (i.e FADAMA III and Abia State Agricultural Development Programme (ADP)) which the researcher believed was an avenue to reach out to the cooperatives. The population for the study consists of 64 cooperatives registered in Umuahia North Local Government. A purposive sampling technique was adopted in the study. The list of all registered cooperative societies were obtained from the Cooperative Office at Umuahia North Local Government Area Headquarters. The total of 8 cooperative societies were selected due to the level of interaction of cooperative societies and the agricultural projects/ programmes (i.e FADAMA III and Abia State Agricultural Development Programme (ADP). Primary and secondary data were used in this study. Data for the study was collected using a well-structured questionnaire administered to respondents who were cooperative officials and were involved in cooperatives activities. The secondary data were collected from the publication of the selected cooperatives and from the State Ministry of Cooperatives, Rural Development and Poverty Reduction. Data collected were analyzed using descriptive statistics such as means, frequency distribution, and percentages.

Results and Discussion

Criteria for selecting members among the cooperative societies

The criteria for selecting members among the cooperative societies is presented in Table 4.3

Table 1: Criteria for selecting members among the cooperative societies

S/N	Variables	Frequency	percent
1.	Members must reside within the area of the operation of the cooperative	8	100
2.	Location of the members business must be within the area of operation of the cooperative	8	100
3.	Willingness to purchase at least the mandatory share capital	8	100
4.	Willingness to attend meetings	8	100
5.	Willingness to be financially committed	8	100
6.	Willingness to be a member	8	100

Source: Field survey, 2017

Table 1: shows that the respondents in Umuahia North all (100%) agreed that members must reside within their area of the operation of the cooperative, Location of the members business must be within the area of operation of the cooperative, Willingness to purchase at least the mandatory share capital, Willingness to attend meetings, Willingness to be financially committed and Willingness to be a member. The lack of adherence to the stipulated conditions could lead to derailment of the cooperatives aim and objectives.

Status/trend of loan application and approval

The status/trend of loan application and approval is presented in Table 4.4.

Table 2 Average numbers of loan application and approval across the cooperatives in Umuahia North.

	Loan Request						Loan Approval						
Name of cooperative	1st Q	2nd Q	3rd Q	4th Q	Total	$\bar{X}$	1st Q	2nd Q	3rd Q	4th Q	Total	$\bar{X}$	App Rate(%)
Ndiagbor	57	60	48	56	221	55.3	32	38	37	44	151	37.8	68.33
Chiluru Farmers	5	-	10	-	15	3.8	3	-	2	-	5	1.3	33.33
Green Revolution	15	5	5	-	25	6.3	9	2	4	-	15	3.8	60
Otu-Obi	11	-	4	4	19	4.8	7	-	2	3	12	3	63.2
Ubibia Cocoa	-	18	-	-	18	4.5	-	15	-	-	15	3.8	83.33
Yes-We-Can	5	30	15	-	50	12.5	5	10	3	-	18	4.5	36
Umunne-ato	11	4	5	-	20	5	4	1	3	-	8	2	40
Ikemba	7	-	3	-	10	2.5	3	-	3	-	6	1.5	60
Total	**111**	**117**	**90**	**60**	**378**	**94.5**	**63**	**66**	**54**	**47**	**230**	**57.5**	
Average	**13.9**	**14.6**	**11.3**	**7.5**	**47.3**	**11.8**	**7.9**	**8.3**	**6.8**	**5.9**	**28.8**	**7.2**	**55.52**

Source: Field survey, 2017

Table 3: shows the difference in loan applied for and approved across the cooperatives societies in Umuahia North. Ubibia Cocoa farmers had the highest approval rate of 88.33%, while Chiluru Farmers had the least value of 33.33%. The table further revealed that Ndiagbor had 221 loan request and 151 loan approval for the year 2016 with their mean as 55.3 and 37.8 respectively as the highest mean across the cooperatives, while Ikemba had the least mean of 2.5 and 1.5 for loan applied for and applied for the first, second, third and fourth quarters of 2016.

Analyses of loan application and loan approval

Analyses of loan application and loan approval is presented in Table 4.5,

Table 3 Analyses of loan application and loan approval

Quarterly	Average number of application	Average number of approval	Approval rate
Quarter 1	111	63	56.76%
Quarter 2	117	66	56.41%
Quarter 3	90	54	60%
Quarter 4	60	47	78.33%
Total	378	230	60.85%

Source: Field survey, 2017

Table 3: shows that an average of 111 loan applications was received in the first quarter for the year 2016 and 63 loan applications were approved giving an approval rate of 56.76%. 117, 90 and 60 loan applications were received, while 66,54 and 47 were approved for the second, third and fourth quarter of the year 2016 respectively, giving an approval rate of 56.41%, 60% and 78.33% respectively. In all, cooperatives societies in Umuahia North received a total of 378 loan applications and approved 230 within the first, second, third and fourth quarter of the year 2016 giving an overall approval rate of 60.85%. An indication that farmers had good access to cooperative loan. This result is in line with the study of Ajah *et al* (2013). The result of Ajah *et al* (2013) showed that in all, the cooperatives societies received a total of 1999 loan applications and approved 1891 within the period of eight years giving an overall approval rate of 94.5%, an indication that farmers had good access to cooperative loans.

Test of Hypothesis

Hypothesis 1-HO_1: There is no significant difference in the production of the selected cooperative societies agro-based enterprises activities before and after cooperative credit.

In order to ascertain whether there is any significant difference in the production before and after cooperative societies credit, the paired t-test was used and the result is presented in Table 4.

Table 4: Significant difference in the production of the selected cooperative societies agro-based enterprise activities before and after cooperative credit.

Growth Parameter	Individual mean	Std Deviation	Std Error Mean	Pooled Mean	Df	T-cal	T-tab
Production before	131066.67	159451.99256	29111.8118	130600.00	29	4.486	1.699
Production after	261666.67						

Source: Field survey, 2017

Decision rule: if T calculated is >T tabulated, reject Null hypothesis and accept alternative otherwise accept the null hypothesis and reject the alternative hypothesis.

Table 4. shows that T calculated for production before and production after was 4.486, while T tabulated was 1.699 with the mean percentage of 99.6%. This means that T calculated is greater than T tabulated, so therefore the alternate hypothesis is accepted meaning that there is a significant difference in the production of the selected cooperative societies agro-based enterprises in Umuahia North. The significant difference in the production could be due to the collaboration of cooperatives with extension workers from relevant government agencies in the state.

Conclusion and Recommendations

It was concluded that there was a positive and significant difference in the production before and production after of the selected cooperative societies, indicating that there is a cooperative society's credit has effect on their agricultural activities. Base on the findings, the following recommendations were made; Cooperatives could avoid loan repayment problems if the cooperatives adhere to the conditions for selecting loan beneficiary, Cooperatives should focus on funding one type of enterprise so as to be effective and efficient in their credit delivery function, Government through relevant agencies should ensure that adequate funds are made available to cooperatives. In addition, policies geared towards improving the capital base of the cooperative societies and managerial abilities that will aid loan repayment capabilities of the co-operators will go a long way to increase the approval rate and reduce the idle time to zero.

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Effects of Macroeconomic Variables on Agribusiness Performance in Nigeria

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Abstract
The response of agribusiness to changes in macroeconomic environment is an important factor in the success of any reform programme in agricultural sector of Nigeria. This study examined the effects of macroeconomic variables on agribusiness performance (AGB) in Nigeria using time series data from 1970 to 2016 collected from the Central Bank of Nigeria (CBN) statistical bulletin. Using the General-To-Specific Auto-Regressive Distributed Lag (ARDL) estimation technique, the results show that only real exchange rate (RER) was very significant in positively influencing agribusiness performance in Nigeria both in the short and long run. The study recommends that the government should intensify price policy measures and other measures that will enhance agribusiness performance in Nigeria.
Keywords: Macroeconomic, Agribusiness and Performance

Introduction
United Nations Industrial Development Organization (UNIDO, 2011) described Agribusiness as an aggregate of sub sectors of agriculture and the proximate agro-allied industries. *Yumkella*, Kormawa, Roepstorff and Hawkins (2011)*elaborated* on this definition to include a wide range of intermediate activities that generate economic values, comprising of not only commercial farming but also broadly include input supplies, agro-processors, traders, exporters and retailers which could be segmented into component groups of: Agricultural input industry; Agro-industries products (food, beverages, leather, textile, etc.); Equipment for processing; and Financing, marketing and other related services. According to Desmond and John (2009), agribusiness emphasizes the interdependence of the various subsectors within the production chain with the aim of adding value to both producer and the consumer. This suggests that for agribusiness to perform successfully in an economy, the interlink between the subsectors or component units must be properly activated and coordinated in order to create a continuous flow of activities, goods and services and information sharing for the purposes of adding value to both the producer and the consumer. The performance of agribusiness in Nigeria is very critical, and apparently seen as a most reliable vehicle of economic growth of the country given the abundant human and material resources, friendly ecological conditions and a wide range of market potentials. If properly harnessed, it can stabilize economic growth, create employment opportunities, and enhance the livelihood of the people living in poverty, in addition to becoming a socially inclusive strategy (Alemayehu, 2014). Indeed, a performing agribusiness is capable of forming the bedrock of the most desired diversification of the Nigerian economy.

Notwithstanding its potentials and past contributions to the economic performance of the nation, there are indications of either stagnated or declining performance at all levels of the production chain. Nigeria, a once major exporter of groundnut, cocoa, palm produce, biggest poultry producer in Africa and other food crops is now a major importer of food items. Nigeria's food import bills stood at ₦33.02 billion in 2010; in 2011, the bill rose to ₦44.3 billion. Available statistical information showed that food demand in Nigeria was increasing at the rate of 3.5% as against the output of 2.5% with a population growth rate of 3.18% (Nto and Mbanasor, 2011).

In an effort to enhance the efficient performance of the agribusiness subsector, various Nigerian governments had formulated and implemented various policies to redirect economic trend to the path of performance. These include Austerity measure, Structural Adjustment Program, Deregulation, Guided deregulation, etc. Many Institutions and schemes were also created such as the River Basin Development Authorities, National Accelerated food Production (NAFP), Operation Feed the Nation (OFN), Directorate of Food and Rural Infrastructure, etc. In spite of these laudable efforts made by various Nigerian governments in committing resources and implementing programs and policies to boost agribusiness, not much seemed to have been achieved. A good macroeconomic policy target and a robust knowledge of behavior of specific macro-economic variables on agribusiness are necessary for redirecting agribusiness to the path of performance in Nigeria. Prominent among these macro-economic variables are: exchange rate, rate of inflation, interest rate, money supply growth, change in real gross domestic product, unemployment rate, government expenditure and net export (Aroriode and Ogunbadejo, 2014; Kadir and Tunggal, 2015).Several studies have been carried out to determine the effects of macroeconomic variables on the performance of production agriculture, agro-allied manufacturing, agro-processing, etc., but not so much information or a holistic study of the agribusiness subsector'sresponse to macro-economic variables changes in Nigeria is known, at least, to the best of the knowledge of the authors.

In the light of the foregoing, the present study analyzed the effects of selected macroeconomic variables, on agribusiness performance in Nigeria from 1970 to 2016. The scope was selected to cover the periods of oil boom and glut in Nigeria.

Methodology

Research Design

The design of the study is ex-post facto. This is because it relied on secondary data collected to investigate the effects of macro-economic variables on agribusiness performance in Nigeria which was set as the primary objective of the study.

Sources and Method of Data Collection

The annual time series data used in the study were collected from the Central Bank of Nigeria Statistical Bulletin, and World Development Indicators Data Base 2017. The data set was collected on each of the selected macro-economic variable specified in the model, and on the proxy for agribusiness performance from 1970 to 2016. Agribusiness performance was proxied by the aggregate growth of the contribution of agriculture real GDP, agro-manufacturing/processing contribution to real GDP, hotel and restaurants services addition to real GDP. The indicator for Non-Oil Export was the ratio of Non-Oil Export to Total Merchandise Exports; real GDP-which is GDP deflated for inflation; crude oil revenue was used as proxy for crude oil export.

Model Specification

The model adopted for this study was influenced by the work of Kadir and Tunggal (2015) who investigated the impact of macroeconomic variables toward agricultural productivity in Malaysia. They stated their model as:

$$LnAGDt = \beta 0 + \beta 1LnEXCt + \beta 2LnEXPt + \beta 3LnGEXPt + \beta 4LnINFt + \beta 5LnMSt + \beta 6INTt + \mathrm{ut}1.$$

Where $LnAGDt$ is the log of agricultural productivity, $LnEXCt$ is the log of the exchange rate, $LnEXPt$ is the log of net exports, $LnGEXPt$ is the log of government expenditure, $LnINFt$ is the log of the inflation rate, $LnMSt$ is the log of money supply, $INTt$ is the interest rate and Ut is the stochastic error term.

Equation (1) was however modified to reflect the focus of the study which is the performance of Agribusiness in Nigeria. Hence the model for the present study is given as:

$$ln\,AGB_t = \beta_0 + \beta_1\, ln\,GDP_t + \beta_2\, ln\,FIM_t + \beta_3\, ln\,NOE_t + \beta_4\, ln\,FPI_t + \beta_5 \ln INF_t + \beta_6 \ln RER_t + u_t \quad (2)$$

where AGB is Agribusiness performance growth; GDP = change in Gross Domestic Product, FIM = Food import growth rate; NOE = Non-oil export growth; FPI = Foreign private investment; INF = Inflation rate; RER = Real exchange rate;*ln* = natural logarithm of the variable, and is t = time period.

Equation (2) predicted that agribusiness performance was positively affected by all the independent variables. The model was linearized so as to standardize the variables.

Data Analytical Technique
The estimation of data was carried out using the General-to-Specific Autoregressive Distributed Lag (ARDL)/Bounds testing technique for testing the long-run co-integrating relationship among the time series variables. According to Pesaran & Shin (2001), the Bounds testing approach has some advantages over conventional co-integration testing approaches because it can be used with a mixture of I(0) and I(1) data, and again, it involves just a single-equation set-up, making it simple to implement and interpret.
As a preliminary step in ARDL/Bound testing, we employed the Augumented Dickey Fully Unit root test to confirm the order of integration of the time series variables. This is necessary because the presence of an order of integration higher than I(1) such as I(2) will invalidate the use of Pesaran and Shin computed F-statistics which is based on the assumption that the underlying variables must be either I(0) or I(1) or mutually integrated. The bounds testing approach was used to confirm the presence of co-integration, i.e. long-run relationship between the variables.

Results and Discussion
The result of the unit root test is presented in table 1

Table 1: Results of Unit Root Tests

Variable	ADF		Order of integration	Philip Perron		Order of integration
	Levels	First difference		Levels	First difference	
NOE	-2.2937	-5.9662	I(1)	-2.2532	-7.2025	I(1)
RER	-0.5074	-4.5956	I(1)	-2.5382	-4.6918	I(1)
FPI	-3.6778	-	I(0)	-3.6778	-	I(0)
INF	-3.0657	-5.7704	I(1)	-3.1644	-14.0650	I(1)
GDP	-4.4860	-	I(0)	-4.5339	-	I(0)
FIM	-3.7582	-	I(0)	-3.7398	-	I(0)
AGB	-4.3365	-	I(0)	-5.3311	-	I(0)

***Source**: Authors' compilation from Eviews printout.*

The result of the unit root test presented in Table 1clearly confirms the existence of a mixed order of integration. Therefore, any attempt to specify the dynamic function of the variables in the level of the series will be inappropriate and may lead to spurious regression. Based on the foregoing, it became necessary to use the ARDL/bound testing approach to test for co-integration.

Table 2: **Result of the General-to-Specific ARDL Bounds Test**
The General-to-Specific ARDL Bounds approach systematically eliminates all the non-significant variables in the model, leaving only the statistically significant variable(s). In this regard, only RER was adjudged significant.
Null hypothesis: No long-run relationship existed

Test statistics	Value	K
f-statistics	14.31575	1

Critical Value Bounds

Significance	10 Bounds	11 Bounds
10%	4.04	4.78
5%	4.94	5.73
2.5%	5.77	6.68
1%	6.84	7.84

K = number of regressors
Source: *Researcher Computation Using E-view 9*

As shown in Table 2, the joint null hypothesis of no long-run relationship was rejected at both 5% and 1% levels of significance. This was based on the fact that the calculated F-statistic value of 14.31575, exceededthe upper and lower bounds critical values of Pesaran and Shin computed F-statisticsat 5% level meaning thatthere is a long-run co-integrating relationship between agribusiness performance and the selected macroeconomic variable, RER.

Table 3: Result of the ARDL Co- integration and Long Run Form

Dependent Variable: LOG(AGB)
Selected Model: ARDL(2, 0)
Date: 07/26/18 Time: 06:18
Sample: 1970 2016
Included observations: 45

Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(AGB(-1))	-0.26146	0.11987	-2.18118	0.035
DLOG(RER)	0.016469	0.004837	3.404584	0.0015
CointEq(-1)	-0.36756	0.074327	-4.94516	0

Cointeq = LOG(AGB) - (0.0448*LOG(RER) + 3.1152)
Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(RER)	0.044806	0.013994	3.201878	0.0026
C	3.115165	0.048733	63.92269	0

The short-run estimates from the model were reported in Table 3. The coefficient of $ECM_{t-1}$was found to be moderate in magnitude, negatively signed as expected and statistically significant at 5% level. It demonstrates that there is a long run relationship between the variables. The coefficient of ECM term is (-0.36756), which suggests a moderate adjustment process. The result suggests that nearly 37 per cent of the disequilibria of the previous year's shock adjust back to the long run equilibrium in the current year. The coefficient of real exchange rate (RER) was statistically significant both on the short- and long-runs. However, contrary to some earlier studies, RER made a significant positive impact on agribusiness performance in Nigeria within the reference period. This result is however in tandem with the findings of Obayelu and Salau (2010) who reported that agricultural output responds positively to increases in exchange rate both in the short and long run. Serial correlation test clearly suggests the absence of autocorrelation as can be seen from Table 4. The final model from the General-to-specific ARDL approach was found to be stable judging from the stability test, F-statistic and R^2. A possible explanation is that increases in the exchange rate lead to increases in aggregate agricultural output probably due to more foreign exchange earnings by farmers through exportation of their products.

Table 4: Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.745559	Prob. F(2,39)	0.1879
Obs*R-squared	3.697251	Prob. Chi-Square(2)	0.1575

Conclusion and Recommendations

The study investigated the effects of macroeconomic variables on agribusiness performance in Nigeria using time series data from 1970 to 2016. Using the General-To-Specific Auto-Regressive Distributed Lag (ARDL) estimation technique, the results showed that only real exchange rate (RER) was very significant in positively influencing agribusiness performance in Nigeria both in the short and long run. It observed that a possible explanation for the development could be that increases in the exchange rate lead to increases in aggregate agricultural output probably due to more foreign exchange earnings by farmers through exportation of their products. The study therefore recommended that the government should intensify price policy measures and other measures that will enhance agribusiness performance in Nigeria.

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Determinants of Household Beef Consumption in Obio Akpor Local Government Area, Rivers State, Nigeria

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Abstract
The study was undertaken to analyze the determinants of household beef consumption in Obio Akpor Local Government Area of Rivers State. Specifically it, determined the quantity of beef demanded on monthly basis by the household consumers and determined the factors influencing the demand for beef in the study area. The primary data used in analysis were collected from sixty randomly selected households in the study area through the use of interview schedule and a well-structured questionnaire. Statistical tools such as frequency counts, mean, percentage and Ordinary Least Square regression were used for data analysis. The results showed that Income spent on beef was 5.24 and that high-income earners spent 2.33% of their income on beef consumption, while low income earners spent 5%. The Cobb-Douglas functional form gave the best line of fit with R^2 value of 0.67. Household size, income level and education level of the respondents were the most significant variables that influenced the household demand for beef in the study area. The major constraint was poor hygiene of abattoir. Abattoirs should be educated on food sanitation process so as to minimize the poor hygienic condition of the abattoirs, Its efforts should be made by the government and other relevant stakeholders to reduce the price of beef by providing the beef producers and marketers with the necessary infrastructures, land and modern technologies so that it can be made affordable to all categories of consumers.

Key Words: Beef, household, consumption, demand

Introduction
Food is a necessity for human growth and meat plays a key role to provide the body with the basic nutrients needed for growth (Aborisade and Carpio, 2017). Nigeria is the largest meat producers in Africa and also the highest meat consumers (Osho and Asgher, 2005). Beef is among the most widely consumed meat in the world, accounting for about 25% of the world meat production after pork and poultry at 38% and 30% respectively (Food and Agriculture Organization, 2002). Meat is a source of protein, vitamins, minerals, micronutrients and fats. Its consumption in adequate quantities facilitates proper functioning of the immune system, mucous membrane and metabolic processes (Biesalski, 2005). The meat from cattle, goat, sheep, pig and poultry including offals are the main sources of protein (Britton, 2003). Animal protein however, is said to possess superiority over other sources of protein. Animal proteins are generally referred to as complete protein because of the presence of different amino-acids in them (Oloyede, 2005). Meats such as beef, being important source of protein, have played important roles in the pattern of food consumption in Nigeria. Beef products are known worldwide as a very important diet because of its high nutritive quality and significance in improving human health (Amao, Oluwatayo and Osuntope, 2006). In addition, consumption of meat reduces the risk of cancer, aeoteriosclerosis and adiposity, while prolonging the onset of diabetes (Ezedinma, Kormawa and Chiamu, 2006). It has been estimate that the daily minimum crude protein requirement of an adult in Nigeria varies between 65g and 85g per person, hence, it is recommended that 55g of this minimum requirement should be obtained from animal protein (Joseph and Ajayi, 2002; Omotosho, 2004). However, beef contribute

46.7gm per day of net protein and the average Nigerian consumes 7.5g of animal protein per day which is still below the recommended requirement by the World Health Organisation (Amao et al., 2006). This shows that the problem of malnutrition and malnourishment; particularly protein intake is a serious one in Nigeria as a large proportion of the population including children do not receive enough calories to ensure physical health and development Meat is considered as an essential food product with high rate of consumption (Guerrero, Valero, Campo and Sanudo, 2013), but the demand for meat in most African countries is very low at 25g and the demand is lower in the Southern parts of Nigeria where the quantity of meat available enough to meet the rapid growth in population due to low production (Obi, 2003). Other problems affecting the demand of beef include: inadequate finance, feed stuff, high transportation cost, inadequate modern storage facilities, ineffective information system as well as low producer prices which may arise as a result of poor distribution network and high cost of procuring trucks and equipment needed for easy marketing (Mintert, Schroeder and Marsh, 2001).

This study is designed to bring to limelight the strength and weaknesses of effective demand of beef production in the study area. Therefore, it will serve as a useful source of information to national development planners and policy makers in formulating policies and designing programmes that will solve the problems affecting the demand for beef thereby increasing the net income of the participating stakeholders and improving the livelihood conditions of household consumers. The specific objectives were to:; determine the quantity of beef demanded on monthly basis by the household consumers; determine the factors influencing the household demand for beef in the study area and to identify the problems encountered by beef consumers in their demand for beef in the study area.

Materials and Methods

The study was carried out in Obio-Akpor Local Government Area of Rivers State. Multistage sampling technique was used in the selection of respondents in the study area. In the first stage, three (3) communities were purposively selected because of the presence of abbatoir in the areas. In the second stage, twenty (20) respondents were randomly selected and interviewed from each of the communities through the use of a structured questionnaire, making a total sample size of sixty (60) household heads.

Data were analysed using descriptive statistics such as frequency, mean and percentages Ordinary Least Square Multiple regression analysis. This is expressed as follows:

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7 \ldots, e)$ ………………………………

Where:

Y = Household demand on beef product (₦)

X_1 = Price per kg (₦)

X_2 = Household size (number of persons)

X_3 = Household income (₦)

X_4 = Gender (Dummy; male = 1, female = 0)

X_5 = Age of household head (in years)

X_6 = Marital status (Dummy; married = 1, single = 0)

X_7 = Education level of household head (years)

e = Error term

Results and Discussion

Household demand for beef.

Table 1: Distribution of respondents according to household demand for beef in the study area.

Quantity of beef consumed	Frequency	Percentages
1 -5	6	10.00
6 – 10	8	13.33
11 – 15	26	43.33
16 – 20	20	33.33
Mean = 12.3kg		
Total	**60**	**100.0**

Source: *Field Survey, 2016.*

Table 1 reveals that 13.33% of the household consumed between (6- 10) kg of beef per month, 10% consumed between (1 - 5)kg, 43.33% consumed (11 - 15)kg while 33.33% of them consumed between (16 - 20)kg. This shows a reasonable consumption of beef in the study area as indicated in the mean (12.3kg) quantity of beef consumed in the area. This could be attributed to the large sizes of their households which has implications for higher consumption of beef.

Factors influencing household demand for beef in the study area.

Table 2: Regression results of the factors influencing household demand for beef in the study area.

Variable	Linear	Exponential	Semi-log	Doulble-log
Constant	44.79	921.9	9.937	-0.457
	(-1.950)	(-3.894)	(14.363)	(-0.250)
Price of beef (X_1)	16.374	646.1	-1.106	-0.001
	(2.102)**	(1.517)	(-0.119)	(-2.009)**
Household size (X_2)	33.46	324.4	0.081	0.650
	(1.809)**	(2.030)**	(1.877)**	(2.430)**
Income (X_3)	10.376	240.2	2.659	0.465
	(2.677)*	(1.211)	(1.566)	(3.075)*
Sex (X_4)	16.745	571.0	0.094	0.068
	(-0.058)	(-0.376)	(0.561)	(0.471)
Age (X_5)	14.844	166.3	0.017	0.431
	(0.477)	(-0.399)	(1.774)**	(0.927)
Marital status (X_6)	95.05	9190.5	-0.197	0.083
	(-0.91)	(0.623)	(-1.124)	(0.551)
Educational Level	23.67	232.0	-0.028	-0.474
(X_7)	(1.533)	(1.745**)	(0.931)	(1.801)**
R^2	0.617	0.547	0.643	0.667
F- Value	10.29	7.712	7.586	12.757

Source: *Field Survey, 2016.* *= significant at 1%, ** = significant at 5%; t-values are the figures in parenthesis

Table 2 shows that the Cob-Douglas functional form was selected as the lead equation based on the statistical significance of the coefficient of multiple determinations (R^2), the significance of F-value, the significance of the coefficient parameters and the conformity with a priori expectations. The results show that the estimated coefficient of multiple determinations (R^2) was 0.67. This shows that 67% of the variations in the exogenous variable was explained by the explanatory variables while the remaining 33% was not accounted for probably due to error term which captures factors not expressed in the model. The F-value of 12.757 was statistically significant at 1% which implies that the model is best fit and hence explaining the variation in quanti2y of beef demanded. Household income, price of beef, educational level and household size were statistically significant at 5% and 1% levels of significance. The coefficients of price and education level were negative and significant at 5%. This implies that the higher the price of beef or/and education level, the lower the quantity dlastic in the study area in that a
unit change in price of beef would reduce the quantity demanded by 0.1%. This observation is in line with the findings of Adetunji and Rauf (2012). Similarly, the negative sign of education level indicates that well educated household head tend to spend less on beef consumption. This is because he is aware of the high calorie content of beef which may have adverse effect on the health status of the individual. The coefficient of household size was positive and statistically significant at 5% while that of household income was positive but significant at1%, implying that the higher the value of these variables the higher the quantity demanded of beef. Therefore, a large household size tends to consume more beef than low household size and increase in household income tend to increase the quantity of beef demanded. This is because there is more mouth to feed in the household, hence more expenditure on beef consumption. This result disagrees with of Mohammed and Eleche (2017) which noted that household size decreases as output increases. Also with respect to income, the income elastic nature of beef signifies that any unit increase in disposable income of household head will result in 0.465 unit increase in quantity demanded for beef.

Problems Encountered by the households

Table 3: Problems encountered by beef consumers in the study area

Problems	*Frequency	Percentage
Poor hygienic condition of abattoirs	35	58.3
High calorie content of beef	26	43.3
Inability to afford beef	30	50.0
Preference differentials of household members	25	41.7
Health reasons	28	46.7

Source: *Field Survey, 2016*
Multiple responses recorded

Results in Table 3 show that majority (58.3%) of the household beef consumers complained that poor hygienic condition of abattoirs is a major challenge. The unhealthy state of abattoirs agree with the findings of Mande (2011) who stated that meat consumers were discouraged owing to the poor hygienic practices of the meat marketers. This was followed by 50% the beef consumers who reported inability to afford beef. This suggests the high cost of beef in the area. This was followed by 46.7% of the households which were limited for health reasons. This could be attributed to the increasing health awareness of beef as having high content of high density cholesterol which is not good for their health. About 41.7% of the respondents reported that preference differentials of household members were the main problem of beef consumption in the household. About 43.3% indicated that high calorie content of beef posed a serious threat to beef consumption,

Conclusion and Recommendations

The study revealed that the beef consumers were mostly married young educated females with large household size in the study area. Level of education, household income and household size are factors that influence the household demand for beef in the study area. The poor hygienic condition of the abattoirs was the major challenge to beef consumption in the study area. The following recommendations were made:

1. Efforts should be made by the government and other relevant stakeholders to reduce the price of beef by providing the beef producers and marketers with the necessary infrastructures, land and modern technologies so that it can be made affordable to all categories of consumers.
2. The beef processors should be educated on the food sanitation process so as to minimize the poor hygienic condition of the abattoirs and
3. The people should be educated on the nutritional value of beef in order to avoid malnourishment from valuable nutrients contained in beef and thereby increasing beef consumption level.

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Structure of Tomato Marketing at Yankaba Market in Kano State, Nigeria

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Abstract

The paper appraised Tomato marketing at Yankaba Market in Kano State, Nigeria. The specific objectives of the paper were to examine the socio-economic characteristics of Tomatoes marketers and describe the Structure of the Tomato Market in the study area. Primary data were collected from fifty (50) randomly selected Tomato marketers with the aid of well-structured questionnaire. Data collected from the field were analyzed using descriptive statistics. The paper revealed among others that: Tomato marketing in the area was male dominated (100%), 80% *of the respondents belong to the active labour force of the population.The market was found to be a perfect one with free entry and exit characterized by little or no role played by marketer's association in price determination: It was recommended that favourable Market conditions should be provided through cooperative initiatives that will lead to the general empowerment of the Marketers especially those with low capital base in order to make them more competitive and hence generally improve their income.*

Key words: Market Structure, Tomato marketing, Yankaba Market, Cooperative Societies, Kano State, Nigeria.

Introduction

Vegetable production has been playing a vital role in human nutrition, poverty reduction and improving the socio-economic status of the farmers. Vegetables are important items in the daily diet of the Nigerian family (Adeoye et. al, 2011). They are a cheap and easily available source of vitamins, minerals and dietary fiber and are low in fat and calories (Abba, 2004). Tomato (*Lycopersiconlycopersicon* karst) is perhaps the most important commercial Vegetable grown all over Nigeria. Both the Wet and Dry Season Cropping contribute immensely to the National requirement (Shehu, et.al, 2013). However, the bulk of the Production is from the Dry Season Cropping particularly under Irrigation in the Northern States and near perennial river banks in the South (Anon,1989). Tomato can grow in a wide range of Climatic conditions. It requires abundant Sunshine and Cool Weather of 20-27^{0c} day Temperature and 15-21^{0C}Night Temperatures (Aderibigbeet *et al*. 1998). Tomato is highly perishable and therefore makes its Marketing important hence the need for studying its Marketing Structure and the concentration of the Marketers.

Market structure also refers to a set of Market characteristics which determines the economic environment in which a firm operates (Thomas and Maurice, 2011). According to Jema (2014), Market structure consists of the relatively stable features of the environment that influence the behavior and rivalry among the buyers and sellers operating in a market. For example, if the market structure is characterized by high barriers to entry, it may result in only a few traders profitably maintaining the business activities. These few traders may engage in non-competitive behavior such as collusion and exclusionary or predatory price setting behavior. These non-competitive behaviors can result in excessive profits and widened marketing margins for traders.

Analyzing market structure is important in understanding the key structural aspects of the Tomato Market and the distribution of its Marketers. This involves the number and concentration of

Market agents, ease of entry and exit, degree of product differentiation as well as the basic operations of its agents at various levels of the Marketing chain. Several studies have analyzed the market structure of Agricultural products in Nigeria. For instance, Abba (2004) analyzed the marketing of Tomato and Onion in Jigawa State while Shafaatu (2017) analyzed structure and Concentration of Rice Market in Kano state. A Gini coefficient value of 0.2 (20%) was obtained implying inequality in size distribution of the sellers' concentration.
It is against this background that this study was conceived in order describe the Market Structure of Tomato with the view of understanding how it affects the price system as well as the Market participants.

The major objective of this paper is to appraise the structure of Tomato marketing in Yankaba Market located along Hadejia Road in Nassarawa Local Government Area of Kano state. The specific objectives are to:

- describe the socio-economic characteristics of the respondents in the study
- determine the Structure of Tomato market in the study area
- Make relevant recommendations

Methodology

Kano state is largely situated in the Sudan savannah agro-ecological except for its southern border which predominantly shows traces of Northern Guinea Savannah. It lies between latitude 13.53^{o} N and 10.25^{o} N and longitude 7.40^{o}E and 10.53°E, and is about 480km from the edge of Sahara Desert (KNSG, 2006). According to Danyaro (2012) the state is 472.45 meters above sea level. It has a total of fourty four (44) local Government areas and share boarders with Bauchi, Jigawa Kaduna and Katsina States with a total land area estimated at 20,760 square kilometers. The main soil type of the study area is reddish brown vegosols, with mainly sandy to clay loam texture. The soils tend to be slightly alkaline, and soil organic matter content and cat ion exchange capacity are low (pH: 8.0, soil organic matter content 0.26%; CEC. 1.34 Me per 100g soil). The latter indicates a dominance of Kaolinite clay minerals. The state climatic condition has two distinct seasons: the dry and wet seasons. The dry season spans the period between October/November to March/April, while the wet season covers the period between May/June to September/October, with an annual rainfall ranging between 787 to 960mm and a temperature raging between a maximum of 33^{0}c to a minimum of 15.85^{0}c although it can fall even lower during Hamatan to as low as 10°C (Olofin and Tanko, 2002). In an official gazette of the Federal Republic of Nigeria released by the National Population Commission (2006), the state had a population of 9,383,682. million people as at 2006 and projected population figure of fifteen (15) million people by the year 2015 making the state the most populous, not only in the region, but also in the country at large. These factors facilitate the diverse nature of Agricultural activities in the state where most of the people are farmers and are actively engaged in the production and Marketing of Grains like maize, millet, cowpea, groundnut, guinea corn and Vegetables. Vegetable crops especially Tomato is mostly grown along Fadama low land areas where the soil is mainly clay – loam textured as well as irrigated perimeters in the state (Ibrahim *et.al*, 2014). Thus, making the primary activity of the people in the study area to be predominantly farming in the rural areas and Marketing/Business in the urban centers alongside other secondary engagements like animal husbandry and civil service there by making the state to become the major Commercial as well as Marketing center across Northern Nigeria comprising international markets like Dawanau (Grains) and Na, ibawa-Yan-lemo/Yankaba Markets (Fruits and Vegetables) among others.

Sampling Procedure

Yankaba Market located along Hadejia road was purposively selected for the study being the single largest Vegetable Market in Kano State, with high concentration of both wholesalers and Retailers. Primary data were used for this study. The primary data were collected from fifty (50) randomly selected Tomato marketers with the aid of well-structured questionnaire supported with interview method for the respondents in the Market.

The data generated include the socio-economic characteristics of the marketers among which are their age, sex, marital status, level of education and their household sizes. Other data include years of experience in Tomato marketing, sources of income, costs and returns of respondents such as marketing costs (transportation cost, handling cost, fees and levies paid), depreciation cost of marketing equipment used, cost of produce, selling price (₦ /fruit), amongst others. Data on Marketing channel i.e. source of product materials used such as table, basket, bag, knife, trays, buckets, basins and umbrella.

Analytical Tools

The tools used for the analysis of the data collected from the field were: Descriptive Statistics. Descriptive statistics such as frequency distribution and percentages were used to describe the socio–economic characteristics of Tomato marketers, determine the Market structure as well as the constraints facing the marketing of the product in the study area.

Results

Socio-Economic Characteristics of the Respondents

Socio economic characteristics describe the personal characteristics of the respondents in the study area. These include age of the respondents, sex, educational level, marital status, household sizes, and marketing experience of the respondents in the study area. Table 1 revealed that 20% of the respondent's ages between 25 - 31, 39 - 45 and 46 - 52 years respectively while 36% and 4% of the respondent's ages between 32 - 38 and 18 - 24 years respectively, implying that majority (80.0%) of the respondents are still very young and are within the active labor force age of 18 to 45.

The study revealed that all of the respondents (100%) were, male which probably has to do with the Socio- religious belief of the majority of the population where purdah is practiced. This conforms with the findings of Shafaatu on the marketing structure of Rice in Kano State. The distribution of the respondents according to marital status revealed that 8 % of the respondents were single, 80% were married, 4% divorced and 8% were separated. This implied that majority of the respondents were married which might have a positive effect on the availability of family labor and help in decision making which directly contributes to the success or otherwise of the enterprise. The result also revealed that 80% of the respondents had Quranic education 12% of the respondents had primary school education, 4% of the respondents had secondary school education, while the remaining 4% had non- formal education otherwise known as Mass Literacy Classes in the Area. It therefore revealed that 98% of the respondents had one form of education or another which implies that watermelon marketers in the study area were moderately educated meaning that they take better decisions in regards to accepting new innovations and applications for better marketing practices.

The study also revealed that majority (80%) of the respondents had between 6 and 10 years marketing experience, while only 16% of the respondents had marketing experiences between 1 to 5 years and 4% of the respondents had marketing experience of 11 to 16 years. This implies that most of the respondents are new entrants and watermelon marketing is new and growing enterprise as new marketers are being added to it daily.

Table: 1. Socio-Economic Characteristics of Respondents

Socio-economic characteristics	Frequency	Percentage
Age Range in Years 18-24		
	2	4.0
25-31	10	20.0
32- 38	18	36.0
39- 45	10	20.0
46- 52	10	20.0
Total	**50**	**100**
Gender		
Male	50	100
Female	-	-
Total	**50**	**100**
Marital Status		
Single	4	8.0
Married	40	80.0
Divorced	2	4.0
Separated	4	8.0
Total	**50**	**100**
Educational level		
Primary School Education	6	12
Secondary School Education	2	4.0
Tertiary School Education	-	-
Qur'anic Education	40	80
Non-formal Education	2	4.0
Total	**50**	**100**
Experience in Tomato marketing		
1-5	8	16.0
6-10	40	80.0
16-20	2	4.0
Total	**50**	**100.0**

Source: Field Survey, 2017.

Market Structure Analysis

The Market Structure is an important Framework that provides crucial insight on how Markets operates especially with regards to a healthy competition among the various actors in the Market (Kang, et al., 2009). Major indicators of Market structure include Entry and Exit, product differentiation, number of buyers and sellers and price determinants which were analyzed below as indicated by the results.

Entry and Exit Behaviour

The result revealed that majority of the Tomato Marketers (84%) believed that there was no any entry restriction whatsoever. While the remaining 16% believed that it was difficult to enter into the Market. Barrier to entry and Exit limits the number of the number of sellers and buyers from entering and exiting the Market thereby affecting competition among and between sellers.

Product Differentiation

Product differentiation is a feature that distinguishes the Market from type of the product being marketed; it is used to gain advantage over and above other competitors (Kang, et al., 2009). The results from table 2 revealed that tomato was found to be differentiated in the Study area according to Grades and majority of the Marketers (44%) were mainly engaged in the marketing of the lowest grade (Taru) probably because of in adequate capital as well as high demand from consumers as a result of its relatively lower price.This is followed by24% involved in the marketing of Grade III and 14% for Grade II respectively. However, only 6% were engaged in the marketing of Grade I by virtue of its relatively high price and therefore implied that only few of the marketers had the capital to invest in it especially when its demand is relatively lower than other Grades In addition, 12% of the respondents were involved in the marketing of all the grades.

Price of Tomato

Prices of tomato in the Market are determined largely by market forces as revealed by the results in table 4. Majority (94%) of the respondents stated that Market forces determined the prices of the commodity in the study area. This implies that sellers are price takers. This showed that a perfectly competitive market structure operates in the retail tomato market. High level of competition allows for the effective operation of the Market forces of Demand and Supply in which case the Price and quantity bought and sold in the Market are at favourable condition for buyers and sellers. In other words this opens more opportunities for potential Marketers to go in to the emerging enterprise.

Table: 2. Market Structure for Tomato (n= 50)

Variable	Marketers Frequency	Percentage
Entry and Exit		
Absence of barrier	42	84
Presence of barrier	8	16
Total	**50**	**100**
Grading		
Grade I	3	6.00
Grade II	7	14.00
Grade III	12	24.00
Others(Taru)	22	44.00
All grades	6	12.00
Total	**50**	**100**
Price of tomato		
Market Price	47	94
Market Officials	0.00	0.00
Comparing Market prices	3	6.00
Total	**50**	**100**

Source: Field Survey, 2017.

Conclusion and Recommendations

The paper revealed among others that: 80% of the respondents belong to the active labour force of the population while the remaining 20% belong to the aged group. It also showed that the enterprise in the Area was Male dominated (100% of the respondents were males). Result showed that 96% of the respondents were literate. The market structure depicts many buyers and sellers and size of the market is large which collectively describes the market as a perfect competitive one. In addition sellers are price takers since price is determined mainly through the interaction between Buyers and Sellers.

It is recommended that more favourable Market conditions should be provided through cooperative initiatives among the marketers that will lead to their general empowerment especially those with lower capital base in order to make them more competitive and hence generally improve their income.

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Effect of Road Transport on Agricultural Development in Ivo L.G.A. of Ebonyi State, Nigeria

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Abstract
Road transport is a major means of transporting farm produce from the farms gate to the markets as well as to various urban areas. This research examines the effect of road transport on agricultural development in Ivo L.G.A of Ebonyi State. Primary and secondary data for the study. One hundred and fifty respondents were sampled systematically in the study area. Descriptive and analytical statistical methods were both employed to analyze the data gathered. The result revealed that road transport has both positive and negative effect on agricultural development in the study area. However, the bad conditions of the road affect cost of transportation of agricultural produce which in turn affect the rural farmers' income. This research concludes by suggesting that improvement in road transport system will lead to increased output by farmers. Thus, Community participation in road transport development should also be encouraged in the study area.
Keywords: *Rural development, marketing, transportation, farm size, output, road network*

Introduction
Agriculture generally is important in the life of every nation for its contribution in improving the standard of living of the people through provision of food for man, feed for animal, hides and skin for clothing, raw materials industries, and timber for shelter. Food in Nigeria is critically dependent on transport distribution, it then become obvious that wide variety of Nigerian food would not be available without the complex transportation network system, which serves as stem food industry. Farm produce usually depend upon transportation facilities. Transport is viewed as an important factor involved in agricultural development all over the world. It is the only means by which food crops produced at farm site is moved to different homes as well as markets, Aderamo, and Magaji, (2010). Transport usually creates market for agricultural produce, raise up interaction among geographical and economic regions and creates new areas to economic focus. There are complex relationships that vary both spatially and over time between transport and development. Therefore, for any meaningful development to take place, transport plays a vital role. Ogunsanya (1988) observed that there are three types of paths in the rural areas which may include bush paths, unsurfaced rural roads and surfaced rural roads. However, the bush path is very common but the least developed of all the routes. Bush paths connects villages with farmsteads and they are usually narrow, winding and sometimes overgrown by weeds particularly during the rainy season. Paul *et al.* (2009) pointed out that the effect of road infrastructure on agricultural output and productivity are particularly important in Sub-Saharan Africa for three reasons. Firstly, the agricultural sector accounts for a large share of gross domestic product (GDP) in most Sub-Saharan countries (Paul *et.al* 2009). Secondly, poverty is intense in rural areas. Finally, inadequate road infrastructure and long travel time leads to high transaction costs for sales of agricultural inputs and outputs, and this limits agricultural productivity and growth. Transport affects agricultural marketing because it is the only means by which farmers can transport their agricultural produce to the market. Low level of transportation in the rural areas has resulted in low income level, low productivity, high rate of poverty and a fall in the standard of living of rural residents (Aloba, 1986). Instances where the distance from the farm to the market is far away with rough road network, causes perishable crops to be destroyed and farmers end up running at a loss (Ajiboye, and Afolayan,2009). It is against this background that this study specifically examines the effects of transportation of produce by road on farmers' farm income.

Materials and Methods

The study was carried out in Ivo Local Government Area of Ebonyi State, Nigeria. It has an estimated population of 129,068 people based on the 2006 census (NPC, 2006). The local government area is composed of the following communities: Ishiagu, Ishiaka, Ndiokoroukwu, Nzerem and Obinagu. The people of this area are mostly farmers and some engage in stone crushing to supplement their farm income. One hundred and fifty (150) farmers were selected from 5 communities in the local government area using a systematic sampling method. In each community, a total of thirty copies of questionnaire were administered to the farm families. The data for the study were collected from two main sources, the primary source and secondary source. The primary data were collected through the use of well-structured questionnaire and personal interviews with the farmers. The questionnaire sought information on farm income, cost of transportation and the effects of transport on agricultural production. Interview and discussions were conducted with the transporters and farmers respectively in order to find out their own opinion about the conditions of the roads to each community sampled. Descriptive statistics such as frequency distribution, percentages and means were used for data analysis.

Results and Discussion

Table 1 shows that about 36% of the farmers generate below N50, 000, 21% make (N50, 000-N100, 000), 29% earn (N101, 000- N150, 000) while about 19% of the farmers generate above N151, 000 and N200, 000.

Table 1 Income level of farmers

Income (naira)	Percentage
10,000-50,000	36
51,000-100,000	21
101,000-150,000	29
151,000-200,000	19
201,000-250,000	9
Total	**100**

Field survey data, 2018

Transportation Cost of Agricultural Produce on Farmers' income

Cost of transportation of farm produce from the farm gate to the market has a great impact on production and income of farmers. This is as a result of transport charges on agricultural produce vary with type of crops, the efficiency of the transport and distance travelled. Table 2 revealed that 14 percent spent nothing less than N20, 000 annually in carting their produce to the market, 26.7 percent spent between N21, 000 and N40, 000, 38 percent of the farmers spent between N41, 000 and N60, 000, 21.3 percent spent between N61, 000 and N80, 000annually to transport their farm produce to thevarious towns where demands are high. This means a significant proportion of the farmers' income was spent on transportation and this is as a result of dilapidated roads infrastructures in these areas. Farmers that spent less than N20, 000 annually are those engaged in vegetable production. This is given the fact that majority (86%) of the farmers earned less than N150, 000 annually from their farm produce. High cost of transportation cost implies high selling price and if the price is too high when compared with other farmers from other areas, customers will not buy and this may result to selling below cost of production.

Table 2: Cost of Transportation of Produce to the Town (Market) Annually

Settlements	Less than N20,000	N21,000-N40,000	N41,000-N60,000	N61,000-N80,000	Total
Ishiagu	1	5	15	9	30
Ishiaka	-	5	12	13	30
NdiokoroUkwu	11	7	10	2	30
Nzerem	5	14	6	5	30
Obinagu	4	9	14	3	30
Total	**21 (14)**	**40 (21.7)**	**57 (38)**	**32 (21.3)**	**30**

Note: Percentages are in Parenthesis

Farmers' Agricultural Productivity level in relation to Transportation of Produce

A lot of factors are responsible for the quantity of crops produced by farmers in the study area and these vary from farm to farm and community to community. These factors include availability of transport, markets, farm size and farm input. Thus 59 percent of the sampled farmers produced 100-5000kg, while 41% produced less than 100kg. This is attributed to the small scale production of the rural farmers. Most of them produce for subsistence and only sell the excess from their production. Transportation problems and other agricultural problems they encountered have really reduced their production capacities. Transportation cost especially has limited their production capacities hence they produce only little at a time.

Conclusion and Recommendations

The study had extensively examined the impact of road transport on agricultural production in Ebonyi State. From the study, it was revealed that road transport has a significant impact on distribution of agricultural produce in the study area. It can therefore be concluded that road transport should be improved upon so as to improve agricultural production generally in the study area. This will in turn generate more income and improve the standard of living of the farmers as well as the inhabitants of the communities under study.

Furthermore, community participation should be encouraged in the construction of roads.

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Impact Assessment of Some Selected Improved Cassava Varieties on the Socio-economic Status of Farmers in Cross River State, Nigeria

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Abstract
The study was conducted to assess the impact of selected improved cassava varieties on the socio-economic status of the farmers in cross river state, Nigeria. The data for the study were collected from 180 farmers. An interview schedule with a well-structured questionnaire was used for the study. The data were analyzed by descriptive statistics such as frequency, tables, percentages, mean and likert scale. The result revealed high awareness and adoption of three out of the five selected improved cassava varieties studied, TMS 89/0505, TME 419, TMS 89/0851, NR 8082 and pro vitamin Aamong the farmers.The result also revealed the socio-economic benefits derived from the technologies adopted. The result shows that farmers adopted those improved cassava varieties that have high impact on their socio-economic status, particularly in food production and income earnings. The paper therefore calls for developing strategies that will enhance high adoption of the technologies by organizing more trainings, field days, and workshops, provision of incentives and seminars for women farmers in the state.
***Keywords**: Improved Cassava Varieties, Impact Assessment.*

Introduction
Assessing the impact of some selected improved cassava varieties for their expected performance on the socio-economic status of the farmers is a pre-requisite and basis for the suitability of new varieties in Nigeria. Cassava is suitable to various farming system, available all the year round and produces efficient food energy (Ironkwe *et al,* 2012, Beeching *et al*, 2000). It is an important food staple and industrial crop in Nigeria. Cassava is also important as a major source of income for rural households, enhances food security and livelihood of people in Nigeria. Nigeria is currently the largest producer of cassava in the World with an annual production of over 54tons from an estimated land area of 1.4 million hectares (Chinaka et al, 2013; FAO, 2009). This record was made possible through the successful research efforts of the International Institute for Tropical Agriculture (IITA), Ibadan, National Root Crops Research Institute (NRCRI), Umudike, other partners and that of the farmers who adopted the technologies developed by these institutes and partners. National Root Crops Research Institute, Umudike has developed several improved cassava varieties to increase the productivity and income of the farmers in the country and to enhance their socio-economic welfare (NRCRI, 2014). These technologies have been disseminated to farmers through the Agricultural Development Programmes (ADPs) of various states in Nigeria for adoption and constant use. Thus, after developing and disseminating technologies, efforts should be made to assess the adoption rate and impact of such technologies on the output, income and general welfare of the farmers. Against this background therefore, it became necessary to examine the impact of these selected improved cassava varieties on the socio-economic of the farmers in Cross River State, Nigeria.

Methodology
The study was conducted in Cross River State in South-South agro-ecological zone of Nigeria. The State is made up of three agricultural zones namely, Calabar, Ikom and Ogoja. A multistage sampling procedure was used in this study. Ikom agricultural zone was purposively selected based

on the fact that Ikom was one of the areas where the improved cassava varieties have been disseminated to farmers through the extension agents in the zone. Secondly, three (3) blocks were randomly selected from the selected zone. A random selection of three (3) circles in each of the blocks was done and in each of these circles, twenty (20) cassava farmers were randomly selected from the list of cassava farmers in the area, making it a total number of 180 farmers for the study. Data collected were analyzed using descriptive statistics such as frequency tables, percentages, means and 5 points Likert-type scale rating.

Results and Discussion

Level of Awareness and Adoption of some selected improved cassava varieties

Table 1 shows the levels of awareness and adoption of the some selected improved cassava varieties in the study area. Results reveals high awareness of all the five selected improved cassava among farmers studied as over 71% of the respondents were aware of the technologies. Greater proportion of the respondents adopted three of the five technologies while TMS 89/0851 and pro vitamin A recorded low adoption.

The socio-economic benefits derived from the technologies adopted

Table 2 reveals the socio-economic benefits the farmers derived from adopting the technologies. Majority of the respondents indicated that TME 419 (88.9%), TMS 89/0505 (78.3%) and NR 8082 (61.1%) benefitted them in food production and income earning while smaller proportion indicated that TMS 89/0505, TME 419, NR 8082 and Pro-vitamin A provided employment opportunities for them. This implies that farmers adopt those improved cassava varieties that have high benefit on their socio-economic status.

Extent the selected improved cassava positively impacted on the socio-economic status of the farmers

Table 3 shows that majority of the selected improved cassava varieties had positive impact on the socio-economic status of the farmers in the study area. Improved cassava varieties like TMS 89/0505, TME 419 and NR 8082 had high impact, particularly in availability of food, income earnings and boosting household economy while Pro-vitamin A and TMS 89/0851 recorded moderate and low impact. This finding agrees with the report of Ironkwe (2012) that farmers adopt those technologies that have high impact on their socio-economic status. The grand mean (3.2) indicated that most of the technologies adopted by the farmers had relative impact on their socio-economic status.

Conclusion

The selected improved cassava varieties such as TMS 89/0505, TME 419 and NR 8082 had high awareness and adoption rate among the farmers in the study area. Though, TMS 89/0851 and pro vitamin A cassava varieties had high awareness but recorded low adoption. However, it is imperative to note that the farmers adopted improved cassava varieties that had relative high impact on their socio- economic status. With the adoption of these improved cassava varieties, the farmers were able to increased availability of food and generate more income from the cassava. Hence, the improved cassava varieties transferred to the farmers in the study area helped to enhance socio-economic status of the farmers. However, efforts should be made by the National Root Crops Research Institute and State ADP to develop strategies that will promote, enhance or encourage high adoption of these improved cassava varieties among farmers in order to generally impact positively on their socio-economic status. This could be done by organizing more trainings, field days, workshops and seminars for farmers in the state.

Table 1: Distribution of Respondents according to the level of Awareness and Adoption of some Selected Improved Cassava Varieties Adopted

Selected Improved Cassava Varieties	Unaware	Aware	Not-adopted	Adopted
TMS 89/0505	36.1	63.9	42.8	57.2
TME 419	11.7	88.3	13.9	86.1
NR 8082	47.2	52.8	46.7	53.3
Pro-vitamin A	42.2	57.8	55.0	45.0
TMS 89/0851	45.0	55.0	54.4	45.6

Source: field survey, 2018

Table 2: Distribution of Respondents according to the Socio-Economic Benefits derived from the Selected Improved Cassava Varieties Adopted

Selected Improved Cassava Varieties	Employment	Food Only	Money Only	Food/Money
TMS 89/0505	20.0	0.0	0.0	78.3
TME 419	47.8	21.7	22.8	88.9
NR 8082	18.9	0.0	0.0	61.1
Pro-vitamin A	11.7	11.1	0.0	30.0
TMS 89/0851	0.0	0.0	0.0	22.8

Source: field survey, 2018

Table 3: Distribution of Respondents according to the Extent the Technologies positively impacted on the socio-economic status of the Respondents

Variables	Very Much	Much	Moderate	Low	Very Low	Total	Mean	Remark
1.Increased availability of food	90(450)	71(284)	11(33)	7(14)	1(1)	782	4.3	Much
2.Wedging poverty	18(90)	29(116)	48(144)	59(118)	26(26)	494	2.7	Low
3.Income generation	35(175)	41(164)	80(320)	15(30)	9(9)	698	3.9	Much
4.Employment for household members	21(105)	39(156)	48(144)	30(60)	31(31)	492	2.7	Low
5.Boosting household economy	34(180)	35(140)	50(150)	41(82)	20(20)	572	3.2	Moderate
6.Meeting some social needs	18(90)	30(120)	64(192)	35(70)	33(33)	505	2.8	Low
7.Acquired new properties	14(70)	29(116)	86(258)	31(62)	20(20)	528	2.9	Low
8.Attaining higher socio-economic status	21(105)	45(180)	49(147)	45(90)	20(20)	522	2.9	Low
Grand mean							**3.2**	

Source: survey work 2018. 5 = Very much, 4 = much, 3 = moderate, 2 = low, 1 =very low.

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Factors Influencing Income Generating Activities of Rural Women in ensuring Household Food Security in Ikwuano Local Government Area of Abia State, Nigeria

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Abstract
This study examined factors influencing income generating activities of rural women in ensuring household food security in Ikwuano LGA of Abia State, Nigeria. Data for this study were obtained by the use of structured questionnaire. A total of 60 respondents were interviewed consisting of women involved in income generating activities. Frequency counts and percentages were used to describe the data collected while multiple regression model was used as inferential statistical tool. The result of the analysis revealed that access to credit positively influence the income generating activities of the rural women at 5% level of probability while marital status of the respondents, level of education and membership of cooperative positively influence the income generating activities of the rural women at 10% level of probability. The study recommends that women should be encouraged to attend adult literacy classes as this will help in better organizing and carrying out of income generating activities. In order to improve on their performance. The local government should assist women by linking them with financial institutions so as to acquire loan and women should be encouraged to form cooperative groups for easier access to loans.
Keywords: Income, Rural women and food security

Introduction
The role of women in income generating activities is of paramount importance to economic growth and development in Africa (Yusuf *et al,* 2015). More importantly, recognizing and supporting this is essential and vital for the development and growth of women and the fulfillment of their economic potentials, while they are often hidden, silent and not appreciated, rural women represent probably the world's most powerful untapped natural resources. Income generation simply means gaining or increasing income or money that an individual or business receives in exchange for providing a good or service after investing capital (FAO, 2011). Women farmers engage in diverse income generating activities in order to ensure their household food security, there are four major elements that constitute food security these include availability, accessibility, utilization and sustainability of access to food. Availability connotes the physical presence of food in large amounts, accessibility suggests sufficient purchasing power or ability to acquire quality food at all times while utilization demands sufficient quantity and quality of food intake (Marilee, 2009). This study therefore was carried out to assess the income generating activities of rural women in ensuring household food security in Ikwuano Local Government Area of Abia State Nigeria. This study examine socio-economic characteristics of the rural women in the study area, identify the various income generating activities of the rural women and factors that influence the rural women choice of income generating activities.

Methodology
The study was conducted in Ikwuano Local Government Area of Abia State. It is one of the seventeen LGAs of the Abia state. It was purposively selected based on the preponderance of numerous income generating activities of rural women in the area coupled with the fact that two renowned National Agricultural Institutions namely National Root Crops Research Institute, Umudike and Michael Okpara University of Agriculture, Umudike are situated in Ikwuano Local

Government Area of Abia State. Simple random sampling was used in selecting 60 rural women involved in different income generating activities. Data for the study were collected using well-structured questionnaire to elicit information from the selected respondents. The data collected were analyzed using descriptive statistics such as frequency, percentage and means as well as inferential statistics (multiple regressions). The model is specified implicitly thus:

$Y = F(X_1, X_2, X_3, X_4, X_5, X_6, X_7 + e)$

Y = Income generating activities

X_1 = Age (in years)

X_2 = Marital status (single 1, married 2)

X_3 = Household size (number of people eating from same pot)

X_4 = Education (in years)

X_5= Farm income (in naira)

X_6= Member of cooperative society (Yes 1, no 0)

X_7 =Access to farm credit (Access =1, non=0)

e = Error term.

Results and Discussion

Socio-economic characteristics

Findings in table 1 show that the highest percentages (98.4%) of the respondents were in between the age range of 35-46 years. This implies that majority of women sampled for the study were in their active age and this is expected to influence their income generating activities in supporting the household food security in the area. Majority (70%) of the respondents were married, indicating high level of involvement in income generating activities. The result of the findings show that majority (57.6%) of the respondents had household of 3-5 persons. The size of the household of the respondents may contribute positively to their involvement in the various income generating activities. In terms of educational attainment, majority (96.7%) of the women attended one form of formal education or the other, while only (3.3%) had no form of formal education. This may be the basis for the women in engaging in various income generating activities. Majority of the farmers (63.3%) belong to cooperative society. This implies that there exists a direct relationship between income generating activities and belonging to cooperative society.

Income Generating Activities of the rural women

The results show the various income generating activities performed by the women (table 2) in supporting their household food security and it was indicated majority of the women engaged in crop production/farming(93.3%). This is followed by trading/marketing (75%), livestock rearing (41.7%), and crop processing (45%). This implies that women sampled engaged in different activities so as to ensure household food security. These findings conform to Food and Agricultural Organization of United Nation who reported that significant roles played by women in addition to unpaid labour are aimed at maintaining the household welfare.

Regression Results on factors influencing the rural women choice of income generating activities.

Table 3 shows the result of the regression analysis on factors influencing the rural women choice of income generating activities. The coefficient of multiple determination (R^2) value of 0.72 indicates that about 72% of variations in factors can be explained by the explanatory variables while the remaining 28% was due to other factors not specified in the model. The result indicated that four out of the eight explanatory variables had positive relationship and were significant at 5% and 10% alpha levels. The estimate showed that marital status, educational level and member cooperative society had a positive and significant relationship at 10% level respectively while access to credit had a positive relationship and significant at 10% alpha levels with the income generation by rural women. This means that as the women acquired more formal education, income generation from cassava increased. This agrees with *a priori expectation* and result of Onyebu (2016) that education enhances the potential of women and makes them take advantage of available opportunities that could enhance their income generating activities. The result showed that marital status increased the respondents' income generation. The result also showed that access to credit and member cooperative society enhances their income generating activities.

Table 1. Distribution of respondents by socio-economic characteristics

Variable	Frequency	Percentage	Mean
Age (years)			
35 – 40	31	51.7	**1.52**
41 – 46	28	46.7	
53 – 59	1	1.7	
Marital status			
Single	7	11.7	**2.12**
Married	42	70.0	
Widowed	8	13.3	
Separated	3	5.0	
Household size			
0 – 2	10.0	10.2	**2.22**
3 – 5	56.7	57.6	
Above 6	31.7	32.2	
Educational level			
No formal education	2	3.3	**3.22**
Primary school	9	15.0	
Secondary school	21	35.0	
Tertiary	27	45.0	
Cooperative membership			
No	22	36.7	**0.62**
Yes	38	63.3	
Total	**60**	**100**	

Source: field survey data 2017.

Table 2: Distribution of respondents by income generating activities

Activity	Frequency	Percentage	Rank
Trading and marketing	45	75	2nd
Livestock rearing	25	41.7	5th
Hair dressing	11	18.3	7th
Crop processing	27	45	4th
Crop production/farming	56	93.3	1st
Catering/sewing	21	35	6th
Others	35	58.3	3rd

Multiple Responses.
Source: Field Data, 2017.

Table 3: Regression Results on factors influencing the rural women choice of income generating activities.

Independent Variable	Coefficient	Standard error	t-value
Age	0.019	0.531	0.036
Marital status	0.370	0.489	0.013*
Household size	-0.688	0.544	-1.265
Income	-0.432	1.258	-0.343
Education	0.655	0.407	2.276*
Access to credit	0.466	0.231	0.047**
Income	-0.258	0.210	-1.226
Member of cooperative society	0.714	0.667	0.039*

Source: Field Survey, 2017, R^2 = 0. 156, Adjusted R = 0.012, NS= Not significant
*** = Significant at 1% ** = Significant at 5% * = Significant at 10%

Conclusion

The study concluded that there exist positive relationships between level of education, marital status, access to credit, membership of cooperative of the rural women and their income generating activities. Sequel to these finding, it is therefore recommended that women should be encouraged to enrol in part time studies in a nearby institution like Michael Okpara University of Agriculture, Umudike or attend adult literacy classes as this will help in better organizing and carrying out of income generating activities. In order to improve on their performance, the local government should assist women by linking them with financial institutions so as to acquire loan and women should be encouraged to form cooperative groups for easier access to loans.

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Analysis of Market Orientation Among Sweetpotato Farmers In South Eastern Nigeria

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Abstract
The study shows an empirical result on analysis of market orientation among sweetpotato farmers in South Eastern, Nigeria. A stratified sampling design which adopted five stage multi methods that involves purposive and random procedures to select 360 respondents with the use of structured questionnaire Heckit selectivity model were used to analyze the determinants of market orientation respectively. The Heckit results shows that the coefficients for education and native of community were directly related to the probability of being market oriented and coefficients for level of orientation, extension contact and household size were directly related to level of market orientation at 10% level. The coefficients for distance from the farm to market and transportation cost were significant at 5% and 10% respectively and indirectly related to probability of being market oriented. More so, the coefficients for gender were negative and significant at 5% and 1% for probability of being market oriented and level of market orientation respectively. The study calls for policies measures such as increasing farmer's access to farming land, credit, education, infrastructural amenities and encouraging women forum in sweetpotato production.
Key Words: Market Revenue, Comparative Advantage, Sweetpotato and Farmers

Introduction
Market orientation is the extent by which a producer use knowledge about the market, as a basis to make decisions on the three basic economic questions of what to produce, how to produce and how to market (Jaworski and Kohli,1996). In sweetpotato enterprise, market orientation is the degree of allocation of resources (land, labor and capital) to the production of sweetpotato that are meant for exchange or sale (Immink and Aarcon, 1993). Berhanu and Moti (2012) noted market orientation as the relative importance of more marketable crops in the crop mix of the household. Underlying market orientation as the profit motive of households as posited by Pingali, (2001), with the realization of profit depending on market revenues following the study of Gebremedhin and Jaleta (2010).The degree of farmer's level of market orientation has been a major determinant of its competitive advantage (Fritz, 1996). Kahan (2013) noted that market-oriented production begins with an understanding of the market, demand, and involvement in the selection of suitable crop and procedures that can supply the demand and generate profits. Although sweetpotato has contributed significantly towards food self-sufficiency over the last years in Nigeria, farmer's knowledge and understanding to market orientation geared toward sweetpotato root production is the key instrument for its commercialization, smallholder inclusion and increased food and nutrition security. The perishability, low value per unit and bulky nature of sweetpotatoes discourage small scale farmers from accessing high price in markets and limits their level of orientation. A better understanding of variable that affect market orientationwith respect to gender will aid in the identification of interventions to unlock and release benefits associated with marketing agricultural products such as sweetpotato. This study is therefore aimed at establishing factors that commands high market-oriented farming among sweetpotato farmers in South eastern, Nigeria with respect to gender.

Methodology

The Study Area: The study was carried out in South Eastern Geo-Political Zone of Nigeria. The Zone lies within latitude 6°N and 9°S and longitude 4°E and 7°W with a total land mass of 10,952,400ha. It is made up of five states namely: Abia, Anambra, Ebonyi, Enugu and Imo States.
Sampling Procedure: A stratified sampling design was used for the study. The design adopted five stage multi method that involves purposive and random procedures to select sample respondents. Three (Anambra, Ebonyi and Enugu State) out of the 5 states in the South-East Geo-Political zone were purposively selected being the top leading states in the zone in sweetpotato production for the study. For the second stage two agricultural zones per state were randomly selected. They were; Anambra and Onitsha for Anambra state, Enugu North and Enugu East for Enugu State, Ebonyi Central and Ebonyi North for Ebonyi State giving a total of six agricultural zones. In the third stage, two Local Government Areas (LGAs) were randomly selected from each zone in the fourth stage, three communities were selected randomly from each Local Government Area giving a sample of 36 communities. In the last stage, 10 sweetpotato producers were systematically selected, giving a total of 360 respondents for the study.
Data Collection Procedure: the data for the study were collected from primary sources with the use of structural questionnaire.
Analytical Procedures: Descriptive statistics and Heckit selectivity model (Heckman, 1979) following a Double Hurdle procedure. In the first stage, Probit link function was used to estimate if producers are market oriented or not and in the second stage, the level of market orientation was estimated simultaneously by Heckit Estimation. This model has advantage over the Tobit model by eliminating sample selection bias as observed by Gebremedhin *et al.,* (2009); Makhura *et al.,* (2001); Siziba *et al.,* (2011) and Ouma *et al.,* (2010).
The models are as specified thus;

Hectic (MOI)= a0 + aiXi + ui (1)

Where MOI= level of market orientation ($\sum \alpha_i L_i / L_i^T$),

$$\begin{cases} \text{MOI=1 if farmer is market oriented,} \\ \text{0, otherwise} \end{cases}$$

a_o = constant for level of Market Orientation equation
a_i= vector of parameters to be estimated for level Market Orientation
x_i = variables for estimation
u_i= error term

In the specific terms, the Heckit model in the second stage of estimation is stated as

MOI = a0 + a1X1 + a2X2 + a3X3 + a4X4+ a5X5 + a6X6 + a7X7+ a8X8+ a9 X9 + a10X10 + a11X11 + a12X12 + a13X13 + a14X14 + ui (2)

Where,
X_1= age (years)
X_2= educational background (years) ‘
X_3= number of times of extension contacts
X_4= capital invested (Naira)
X_5= household size
X_6= distance to the nearest market (km)
X_7= area of sweetpotato (hectare)
X_8= native of community (dummy variable; yes =1, No=0)
X_9= farming experience (years)
X_{10}= marketing experience (years)
X_{11}= sweetpotato yield (kg/hectare)
X_{12}= transportation cost (Naira/bag)
X_{13}= road condition (good = 1, bad =0)
ui= error term

Result and Discussion

The results in Table 1 show the determinants of market orientation among sweetpotato producers in south eastern, Nigeria. The χ^2 was highly significant at 1.0% level of probability. The inverse mills ratio (lambda) for the level of market orientation was significant, implying that a sample selection bias would have resulted if the level of market orientation was estimated without taking into account the decision to be market oriented. Heckman estimated ρ (rho) as 0.55, the correlation of the residuals in the two equations and sigma (σ = 10.4226), the standard error of the residuals of the market orientation equation. In this case we can reject the null that rho = 0, so indeed we should be using a sample selection model on this data.

The coefficients for education and native of community were significant at 10% and directly related to the probability of being market oriented and level of orientation. This suggests that a 1% increase in level of education will results in 0.0633%, 0.0187% and 0.082% for education and 1.060%, 0.340% and 1.409% for native of community increase in being market oriented, level of orientation and for all producers respectively. Investing in agricultural crop requires skills and information that individuals whom are educated may possess or acquire more easily than others following Rios *et al.,* (2008). Ethnicity reduces barriers to communication and cooperation (Rios *et al.,* 2008). The coefficients for extension contact and household size were significant at 10% level of probability and directly related to level of market orientation. This indicates that any 1% increase in number of extension contacts will lead to an increase in level of market orientation for all the sweetpotato producers.

The coefficient for capital invested was significant and directly related to probability of being market oriented at 5% level. This implies that a 1% increase in capital will result to 0.00001% and 8.49 $\times 10^{-6}$% for being market oriented and for all the farmers respectively. The coefficients for distance from the farm to market and transportation cost were significant at 5% and 10% respectively and indirectly related to probability of being market oriented. This implies that a 1% increase in distance from farm to market is expected to lead to a 0.0465% and 0.0744% decrease in being market oriented and for all the farmers respectively. Consequently, through negative multiplier effects, distance can have severe implications for market orientation following the findings of Omiti *et al*., (2009). Thus, the variable transport costs per unit of distance increases with the potential marketable load size thereby influencing the probability of being market oriented. The coefficient for area of sweetpotato cultivated, farming and marketing experience had a directly related to probability of being market oriented at 1%, 10% and 5% level of probability respectively indicating that a 1% increase in area cultivated sweetpotato will lead to an increase in being market oriented. Experience has been known to lead to perfection in activities. This resultantly manifests in increased knowledge of techniques or otherwise involved in any enterprise. This result is consistent with Agwu (2009) and (Agwu and Ibeabuchi, 2011).The coefficients for gender were negative and significant at 5% and 1% for probability of being market oriented and level of market orientation respectively. This implies that the females tend to increase their probability of being market oriented, level of market orientation and for all the farmers by 0.960%, 0.466% and 1.426% respectively compared to their male counterparts. Female headed households are more likely to be market oriented in sweetpotato production than the male-headed households, and this is in line with the findings of Arega *et al.*, (2007) who studied livestock markets in Kenya and Makhura *et al.,* (2001) in maize markets in South Africa. Having a female headed household increases a household's probability of selling its sweetpotato by a greater amount than due to other factors. This implies that women are more inclined to sell their sweetpotato than men, the result in contrast to the expected outcome, but possibly because women are better at bargaining than men. Female farmers also tend to experience lower transaction costs since they tend to have more credibility following the findings of Okoye *et al.,* (2016).

Conclusion

The study analyzed the determinants of market orientation among sweetpotato farmers in South Eastern, Nigeria. A number of variables were showed to affect market orientation in the study area which includes education, native of community, capital invested, distance from farm market, transportation cost, area of sweetpotato cultivated, farming and marketing experience and gender. Understanding the importance of market orientation towards commercialization and agricultural development is one step to help economies to get back on track and still maintain increased sweetpotato system A This would help to reach the goal and reducing the status of poor rural farmers. The study call for policies in measure es like: increasing farmer's access to farming land, credit, education, infrastructural amenities and encouraging women forum in sweetpotato production.

Table 1: Determinants of Market Orientation among Sweetpotato Farmers in South Eastern Nigeria: Heckit Results (Pooled)

Variables	parameters	MO or not	Level of MO	Total
Age of the farmers (years)	X1	-0.0145 (-1.04)	-0.0053 (-1.03)	-9.2 x10-3 (-2.07*)
Educational level (years)	X2	0.0633 (2.36*)	0.0187 (1.98*)	0.082 (4.34***)
Number of extension contacts	X3	-0.0208 (-0.82)	0.0136 (1.72*)	-7.2 x10-3 (0.90)
Capital (Naira)	X4	0.00001 (2.88**)	-1.51 x10-6 (-1.05)	8.49x10-6 (1.83*)
Household size	X5	0.0283 (0.30)	0.0618 (2.17*)	0.0901 (2.47**)
Distance from the farm to market (km)	X6	-0.0465 (-2.87**)	0.0021 (0.23)	-0.0744 (-2.64**)
Area of Sweetpotato planted (ha)	X7	2.8922 (4.32***)	-0.00002 (-0.00)	2.8922 (4.32***)
Native of community	X8	1.0609 (1.95*)	0.3402 (2.25*)	1.4092 (4.2***)
Farming experience (years)	X9	0.0562 (2.00*)	-0.0015 (-1.04)	0.0547 (0.96)
Marketing experience(years)	X10	0.1253 (3.35**)	0.0010 (0.09)	0.1263 (3.44**)
Yield (kg)	X11	0.00007 (-1.24)	0.00001 (0.80)	-6x10-5 (-0.44)
Transportation cost (Naira)	X12	-0.6627 (-2.23*)	0.0237 (0.22)	-0.639 (-2.01*)
Road condition	X13	-0.2961 (-1.02)	0.0788 (0.87)	-0.2173 (-0.15)
Gender	X15	-0.9603 (-3.42**)	-0.4663 (-4.37***)	-1.4266 (-7.79***)
Constant	B0	1.0643 (0.94)	0.4908 (1.20)	1.551 (2.14*)
ƿ(rho)		0.5540		
ʎ(mills' ratio)		5.7741 (0.0262***)		
χ2 (chi- square)		58.76***		
σ (sigma)		10.4226		
No of observations		360	228	

Source: STATA 13 Results. *, ** and *** = Significant at 10%, 5% and 1% respectively. Figures in parenthesis are t-value, MO = Market Orientation

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Profitability Analysis of Cassava Production in Ido Local Government Area of Oyo State

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Abstract
The Study assessed on profitability of cassava production in Ido Local Government Area, Oyo State, Nigeria. It examined cost and returns to cassava production and also determined the factors affecting cassava production in the study area. Data were collected through the questionnaire and analyzed using. Budgetary analysis and Regression model. The results showed to the cost and return to cassava production, the total and Average variable cost is ₦ 27,316,500 and ₦23, 753,478.26, respectively. The total Gross margin and Gross margin per producer is ₦34,536,086.96 and ₦39,716,500 respectively. The Total net income and net income per marketer is ₦43,902,739,13 and ₦50488950 respectively. It is therefore concluded that cassava production in the study area is operating profitably and also material cost was found to have positive significant effect on the cassava production. It is recommended that Government should provide adequate capital inform of loans and subsidized farm input to the farmers to improve cassava production in the study area

Introduction
Cassava is believed to have originated in Northern Brazil and Central America. This popular crop is now grown in almost every tropical country. In Nigeria it was introduced to Warri (in the then Bendel State of Nigeria) by Portuguese explorers from the 16th to 17th century (Yakasai*et al* 2008). Since then Nigerians have accepted cassava as one of their main dish, because of its high demand both locally and internationally, its cultivation should be given more consideration now than ever before. Nigeria is an agrarian society with about 70 percent of over 140 million of her population engaged in agricultural production (CBN, 2006). Nigerian agricultural production is operated by large number of small producers with little capital, who produce more than 90 percent of the total food crops (CBN, 2004). Cassava is one major crop produced by the numerous small-scale farmers in Nigeria and its production has been increasing over the past two decades in terms of the area cultivated and the yield per hectare. The growth in cassava production has been primarily increased due to rapid population growth, large internal market demand complemented by the availability of high yielding improved varieties of cassava, a relatively well developed market infrastructure, the existence of improved processing technology and a well-developed internal market structure(Ajibefun and Daramola, 2003). Nigeria grows cassava more than any other country in the world with an annual production currently put at about 34 million metric tonnes per annum and the total area cultivated for the crop in 2003 was 3.1 million hectares with an average yield of about 11 tonnes per hectare (FAO, 2007). The total area cultivated has risen to 3.8 million hectares with an average of 11.84 metric tonnes per hectare in 2005 (FAO, 2002).The presidential initiative on cassava in Nigeria set in motion the process of achieving economic growth through cassava production. Stressing the influence of the presidential initiative on cassava in Nigeria, in 2005 it was observed that the trade promotion policy of the federal government has created a very strong domestic demand and market for cassava. The need to diversify and expand the uses of cassava such as production of ethanol, starch and livestock feed and household floor is said to be necessary so as to realize the benefits derivable from domestic markets and as raw materials for industries (Nweke, 2004). IITA (2004) noted that poverty reduction can be attained in Sub-Sahara Africa by improving the technical and economic efficiencies of food production in

crops such as cassava. The cash income from cassava proves more egalitarian than the other major staples because of cassava's low cash input cost (Nweke, 2003).

Methodology

The study was carried out in Ibadan atIdo Local Government Area of Oyo State. The sampling procedure involves two stages. The first stage were purposively selection of three wards out of the ten wards in Ido local government, in each of the three wards selected three villages were selected purposively due to the large population of cassava farmer in the areas. The villages include Akufo, Idigba, Araromi, Omi-Adio, Omi-Onigbagbo, Bakatari, Aba Eemo, Alako, Ilaju, making a total number of nine villages. A total number of 123 questionnaires were distributed among the small-scale cassava growing farmers. based on the population size of the cassava growing farmers in each ward, while 115 questionnaires were retrieved.

Results and Discussion

Costs and Returns of Cassava Production

S/n	Items	Price (₦)
1.	Total Variable Cost	27,316,500
2.	Average Variable Cost/Producer	237,534,782.6
3.	Total Fixed Cost	16,544,850
4.	Average Fixed Cost	143,868,260.9
5.	Gross Revenue	582,895,652.2
6.	Gross Revenue/Producer	67,033,000
7.	Gross Margin	345,360,869.6
8.	Gross Margin/producer	39,716,500
9.	Net Income	439,027,391.3
10.	Net income/Producer	50,488,150

Source: Field Survey, 2016

The summary of the cost and returns of the activities of cassava producer in the study area is shown in table above. The result shows that the Total and Average Variable Cost is ₦27,316,500and ₦237,534,782.6 respectively. The Gross Revenue and Revenue per producer is ₦ 582,895,652.2 and ₦67,033,000 respectively. The Total and Average Fixed Cost is ₦16,544,850 and ₦143,868,260.9 respectively. The Total Gross margin and Gross margin per producer is ₦345,360,869.6 and ₦39,716,500 respectively. The Total Net Income and Net Income per marketer is ₦439,027,391.3 and ₦50,488,150 respectively. Cassava production in the study area is thus operating profitably. This is agreement with work done by Muhammad *et al.,* (2012) on economics of improved and local varieties of cassava production.

Factors influencing cassava production

Model	Beta	Standard error	t-value	Sig.
Constant	-75541.714	102492.760	-0.737	0.462 NS
Gender	2529.247	33631.201	0.075	0.940 NS
Age	23913.457	26987.744	0.886	0.378 NS
Marital status	3153.931	28967.535	0.109	0.914 NS
Education	7014.339	27606.044	0.254	0.800 NS
Household	8147.895	17704.987	0.460	0.646 NS
Experience	-15549.196	18439.145	-0.843	0.401NS
Material cost	3.991	0.70	56.710	0.000*

Source: Field Survey, 2016
R^2 = 96%
Prob. (F-stat) - 0.05
* Significant at 5% level of probability
NS - Not significant at 5% level of probability

From the table above, it is shown that material cost as a positive influence on cassava production while age, gender, marital status, education and household size have no significant effect on cassava production in the study area. Adjusted R^2 of 96% however, indicates a good fit for the regression equation.

Conclusion and Recommendation

The results showed that the cassava production is profitable. This can be attributed to the value of the gross margin, gross revenue and net income of the cassava producer in the study area. Material cost was found to have positive significant effect on the cassava production. The following are recommendations based on the research findings:

Government should provide adequate capital, subsidized farm input, modern storage facilities, effective extension service, good road network for free access, available market and implement favourable policies for the farmers to increase cassava production

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ASN 52nd Annual Conference Proceedings

Analysis of Small-Scale Irish Potato Farmers Income in Plateau State

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Abstract
The study examined the profitability of Irish potato farmers in Plateau State. A cross-sectional survey of 80 farmers selected through a multistage sampling effort was done and descriptive statistics and gross margin tool were employed in the data analysis. The study revealed that 62.50% of Irish potato farmers were in the age bracket of 36-45 years and both male and female engaged in Irish potato production in the area. Majority (53.8%) of the farmers were married with mean household size of 9 members. Majority (86.2%) of Irish potato farmers in the area attended school. The production of the crop was found to be profitable with a mean income of ₦48, 400 per ha and returns on investment (ROI) of ₦1.34. The constraints that limit productivity of the farmers were potato blight disease, high input costs and poor infrastructures. The study therefore recommended that policy makers and all stakeholders in the Irish potato value chain should device motivational package that will encourage youths to participate in farming and also more extension specialists should be recruited and trained to guide farmers on the recommended practices of Irish potato production as well as management of diseases for better and improved output.

Keywords: Income, Blight, ROI, Policy

Introduction
Irish Potato (*Solanum tuberosum*), is an important commodity to farmers, traders, and consumers. It is grown to supplement staple crops particularly the cereal crops and also add to the household economy through increased income to farmers. It was first domesticated in the Andes Mountains of South America (IPC, 2015). Irish potato requires an optimum temperature of 15^{o}C for tuber formation (NRCRI, 2015). The crop is a temperate region crop which requires cool climatic conditions to grow. It grows well in temperatures between 15^{0}C to 25^{0}C and high day temperature of 20-25^{0}C is good for vegetative growth while 15-20^{0}C night temperature is good for tuber formation. Tuber formation stops totally when the temperature goes above 30^{0}C (Agriinfo, 2015).

According to FAO (2007), the world three largest producers of potato are China (72,040,000 tons), Russia (36,784,200 tons) and India (26,280,000 tons), incidentally some of the most densely populated countries on earth. In Africa, a total of 1,541,498 ha of land is cultivated annually, producing about 16,706,573 tonnes of potato with an average of 10 tonnes/ha (FAO, 2007).

The enterprise is facing a lot of threat, which includes problem of late potato blight coupled with the ever-increasing cost of procuring inputs and poor marketing of tubers has, to a great extent, limit farmer's productivity. Therefore, this study is designed to determine the income of Irish potato farmers in Plateau state and also describe the socioeconomic characteristics and the constraints faced by farmers therein.

Methodology
Plateau State is located in the North Central geopolitical zone of Nigeria. The State has a land area of 30,913 km^2 with a projected 2018 population of 4,206,969 base on the 2.6% annual growth rate of 2016. The State is about 1230m above sea level, with about 1400mm of annual rainfall which spans from April to October (NRCRI, 2015). The climatic condition of the State is suitable for potato production because they meet the required 15^{0}C for tuber formation. Other crops produced in

these areas include tomato, cabbage, carrots, lettuce, cucumber, green beans and onions. Cereal crops such as maize sorghum and millet are also grown in the area. Over 80% of the potatoes are produced as a sole crop during the dry season and in mixtures during the rainy season.

Sampling Procedure

Plateau State is made up of 17 Local Government Areas (LGAs), and 9 LGAs are known for Irish potato production. Pankshin LGA was conveniently selected because it is safe in terms of security and research could be conducted without exposing the researcher to the frequent ethnic crisis in the State. The villages of Fier, Mile 8, Bwarak, and Tambes were selected purposively because they are among the Irish potato producing sites in Pankshin LGA. Finally a systematic random sampling was used to select 80 Irish potato farmers from the various villages (20 from each village).

Data Collection

Data for the research was collected from primary source through oral interview using structured questionnaire. The data were collected by trained enumerators while the researcher supervised the data collection process.

Tools of Analysis:

Descriptive statistics (such as frequencies and percentages) and Gross Margin Analysis were employed in data analysis: The Gross Margin model is given by $GM = GR - TVC$

Where;

GM = Gross Margin (₦/Ha)

GR = Gross Revenue (Gross Sales) = Total output (kg/ha) x Unit Price (₦/Kg)

TVC = Total Variable Cost (sum total of all costs of buying variable items such as seeds, fertilizer, agrochemicals, labour etc.)

The ratios used to further ascertain the enterprise profitability are;

Gross Ratio: This is given by;

$G.R = \frac{TVC}{GI}$ Where; G. R = Gross ratio TVC = Total variable cost

GI = Gross Income given by; GI = Total Irish Potato Output (kg) x Unit Price (₦/kg)

It shows the proportion of the gross income that goes to pay for the operating costs.

Return on Capital Investment: This is the amount that every capital (Naira) invested will pay back after been committed in a production or business cycle. It is given as;

$ROI = \frac{GI}{TVC}$

Where; ROI = Returns on investment GI = Gross Income (₦) TVC = Total Variable Cost (₦)

This shows the returning power of every naira invested and they altogether determine whether a farmer remains or is removed out of business.

Results and Discussion

The majority (62.5%) of the farmers were male and 37.50% were females. The mean age of Irish potato farmers was 40 years with the majority (62.50%) of the farmers in the 36-45 age group and the least (3.8%) belonging to the 56-65 age group. Majority (53.8%) of the farmers were married followed by the widowed with 22.5% and only 11.3% were found to be divorced. The mean household size was 8 with a larger portion (52.9%) belonging to the 7-10 members. A mean land size of 2.6ha was cultivated by Irish potato farmers, a larger proportion (42.5%) cultivated between 0.1-1.0ha of land, while 22.50% cultivate between 1.1-2.0ha of land. Majority (50.0%) of the farmers had farming experience of 1-10 years. Forty percent (48.00%) attended post-secondary education followed by 18.8% with secondary school education and the least (13.8%) with no formal education. Among the benefits drawn from association membership, over 59.3% benefits through training, 28.8% with production inputs and 11.9% through Loan/Credit.

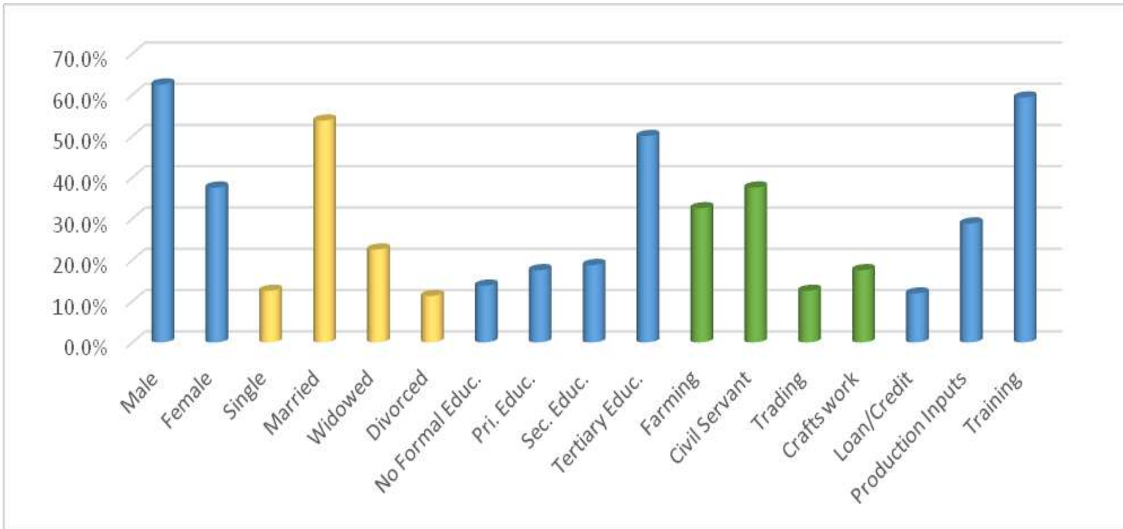

Fig. 1: Qualitative Socioeconomic Characteristics of Irish Potato Farmers
Source: Field Survey, 2017

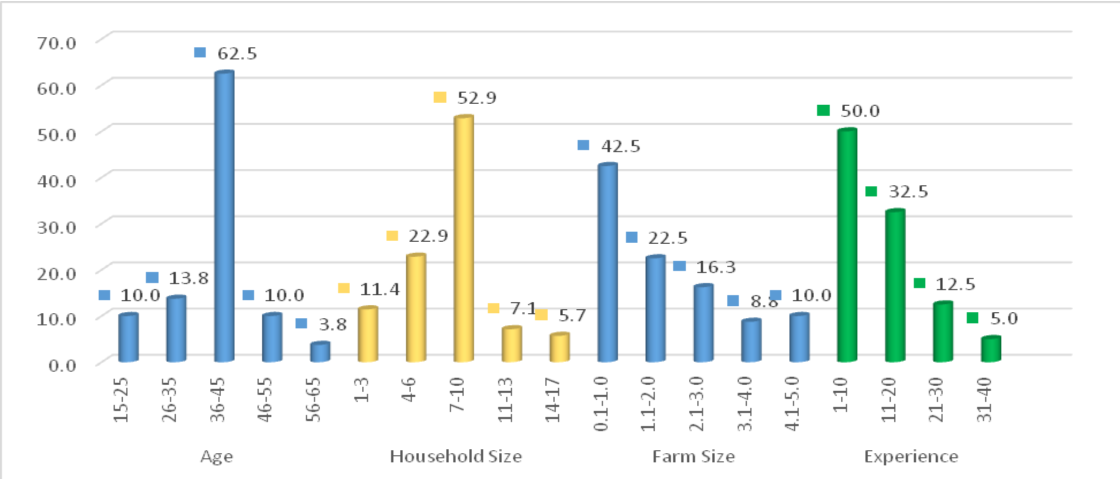

Fig. 2: Quantitative Socioeconomic Characteristics of Irish Potato Farmers
Source: Field Survey, 2017

Table 1 shows that over 29.9% of the total cost of Irish potato production was spent on seed procurement, 25.4% on labour cost, 18.7% spent on purchase of agrochemicals, 18.3% on fertilizer purchase, 4.2% as transportation costs, 1.90% spent on purchase of organic manure and 1.6% for bag costs. A mean gross margin of the farmers was ₦48, 400 per hectare, the returns on every naira invested was 1.34 and a gross ratio of 0.61.
The finding of this study agrees with the results of Jwanya (2014) and Ayodele (2005) where both reported that Irish potato was a profitable venture and that the costs of seeds, labour and fertilizers were the major costs of Irish potato production and hence were the most demanding variable items for the crop in question.

Table 1: Costs and Returns Analysis

Variable Inputs (₦/Ha)	Cost(₦/Ha)	%
Seeds	42,460	29.87
Fertilizer	26,041	18.32
Organic fertilizer	2,656	1.87
Agrochemicals	26,631	18.74
Labour	36,137	25.42
Transportation Costs	5,941	4.18
Cost of bags	2,270	1.60
Total output (kg/Ha)	934	
Unit Price (₦/kg)	204	
Gross Income	190,536	
Total Costs	142,136	
Gross Margin	48,400	
ROI	1.34	
OR	0.75	

Field Survey, 2017

Figure 3 shows the constraints to Irish potato production in the study area. The common problems limiting Irish potato production were potato blight disease (100%), high input costs (100%) and poor infrastructures (83.8%). Other constraints were inadequate credit facility, limited contact with extension agents and poor pricing as reported by 47.5%, 26.3% and 25.0% respectively.

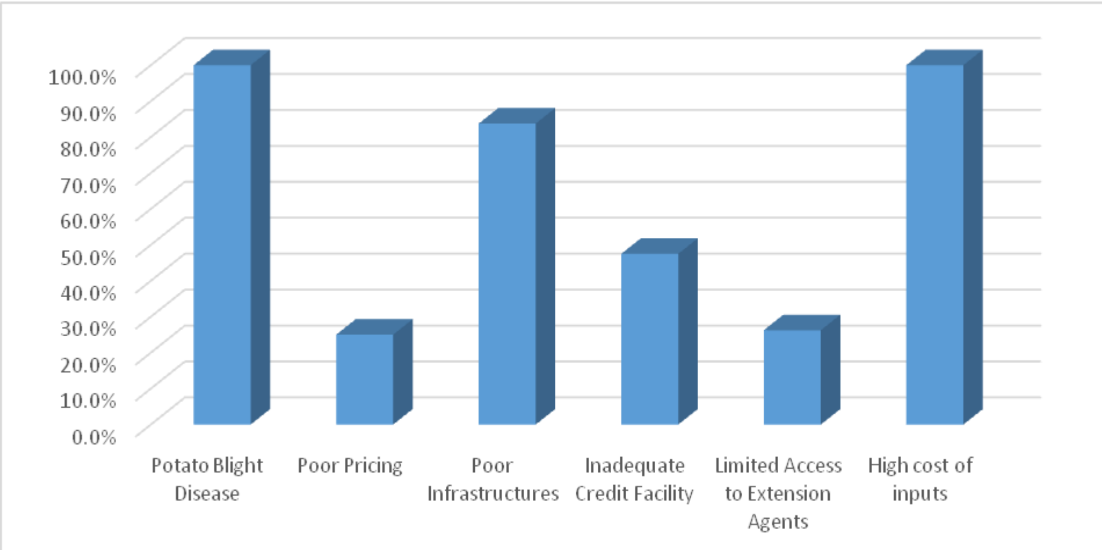

Fig. 3: Constraints Faced by Irish Potato Farmers
Field Survey, 2017

Conclusion and Recommendations

The study described the socioeconomic characteristics of potato farmers, determined the gross margin and constraints of Irish potato production in Plateau state. The study revealed that Irish potato production is a profitable enterprise though farmers are challenged with blight disease, high input costs and poor state of infrastructures. Hence, the study made the following recommendations:

i. There is need for both government and research institutes and all related stakeholders to come up with policies and other motivational package that will awaken the interest of youths to partake in Irish potato farming as a business.
ii. More extension specialists should be recruited and the ones on ground be retrained on how to guide and feed farmers with updated facts about Irish potato production and also on how to counter the deadly blight disease of potato.

iii. Also, efforts should be made to see that group formation among farmers becomes common as this will help them have a mouth on the prices offered and also will be able to counter against all problems that might claim difficult to be addressed individually.

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ASN 52nd Annual Conference Proceedings

Documentation of Research on Vegetables and Spices in the Proceedings of the Agricultural Society of Nigeria between 2007 and 2016

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Abstract
This paper examined vegetables and spices research in Nigeria as contained in the publications of Agricultural Society of Nigeria (ASN) conference proceedings (2007 – 2016). The number of technical and symposium papers was compiled, while papers pertaining to vegetables and spices were also determined as present in a total paper per volume. The findings revealed that total of 2,651 technical papers were presented during the period of study and a total of 131 and 65 papers were presented on vegetables and spices, representing 4.94% and 2.45%, respectively. Findings revealed that University had the highest contributors (4.38%), while Colleges of Education had the least (0.036%) contributors. National Root Crop Research Institute, Umudike and Ahmadu Bello University, Zaria had the highest contributors of 42 and 18, respectively. ASN conference of 2016 had the highest contributors on vegetable and spice crops. There was low frequency of publications pertaining to vegetable and spice crops compared to other aspect of production. Capacity building of appropriate personnel to steer the much-needed development in the research on these crops is imperative and is advocated.

Introduction
Vegetables are soft edible plant or plant products such as leaves, petioles, stems, inflorescences and fruits (Balogun *et al*, 2009) and roots. They are herbaceous plant species with various morphological utilized parts. Many types of vegetables grown for their nutritional values in Nigeria include leafy, fruits and root vegetables. According to Ogunniyan and Akinfosoya (2007), vegetables are those horticultural food crops which are not desert fruits, dry pulses, nuts, herbs or large starch crops. They are edible fresh non – toxic succulent plant parts (fruits and leaves) that can be eaten raw or cooked with or without other ingredient. They serve as food for growth and development, and as socio-economic product serving aesthetic and other satisfactory functions. Vegetables are rich in vitamins and minerals and constitute one of the very indispensable items of Nigerian kitchen.

Spices on the other hand, are products from plant seeds, fruits flowers, roots or rhizomes, leaves or bark that are added to food to improve flavor, taste, colour or act to minimize the rate of rancidity and as preservative that suppresses microbial activities. Spices possess phytonutrients, essential oils, anti-oxidants, minerals and vitamins that are essentials for overall wellness of both adults and children (Thomas, 2007, Teye *et al*, 2013). Research have shown that spices such as fenugreek seeds, garlic, onion, turmeric, ginger, mustard, curry leaves and coriander possess potential anti-diabetic agents (Asif, 2011; Xinyan *et al*., 2017; Yahaya *et al*., 2010; Schippers, 2000. Studies have shown that there are diverse plants in Nigeria known as vegetables (Denton and Olafolaji, 2000), but many are not widely utilized and many of these vegetables and spices consumed locally in Nigeria are not reported or documented. The need for relevant and reliable information on identification, evaluation, propagation, production, utilization and patent right issue of Nigerian rich vegetable and spice plants bio-resources however, can only be created through scientific research investigations on these species, apart from indigenous knowledge about their management and conservation in the various localities of natural distribution and adaptation. In a bid to examine how the country's agricultural professionals had fared to harness the great potentials of vegetables and spices, to contribute to national health scheme, socio-economic growth and development, the study was conducted.

Materials and Methods

Information about vegetables and spices research inputs and nature of research were obtained from 10 volumes conference proceedings of ASN across 10 years period that took place in different host cities in Nigeria. Articles published on vegetable and spice crops in the conference proceedings were analyzed. Data collected from the articles included author's affiliation, distribution of articles based on institutional type, vegetable and spice crops whose research involved in-depth study and reports, or mentioned in the survey report were noted.

Results and Discussion

Entries in Table 1 showed that ten cities across Nigeria geo-political zones hosted the ASN annual conference at different times between 2007 and 2016, of which Abuja hosted two times during the period. A total of 2,651 scientific papers were presented in ASN conferences over the years in review. Result showed that between 2007 and 2016 4.94% and 2.45% of the papers dealt with vegetables and spices respectively.

Table 1: ASN Annual Conferences Held between 2007 and 2016 in Nigeria

S/N	Organizer	Theme	Host City	Year
1.	Institute of Agricultural Research/Ahmadu Bello University	Reviving Agriculture for Sustainable National Growth and Stable Democracy	Samaru, Zaria	2007
2.	Ebonyi State University	Agricultural Development in Nigeria: Issues and Challenges	Abakaliki	2008
3.	National University Commission and RMRDC	Global food Crisis and Nigeria Agriculture	Abuja	2009
4.	Laloke Akintola University of Technology	Re-strategizing Nigerian Agriculture in a Rapidly Changing Climatic Conditions for Sustainable Food Security	Ogbomoso	2010
5.	Usman Danfodiyo University	Mobilizing Agricultural Research towards attaining food security and industrial growth in Nigeria	Sokoto	2011
6.	Bayero University	Agricultural Transformation in a deregulated Economy: Prospect and Challenges	Kano	2012
7.	Federal College of Animal Health and Production Technology	Revamping Nigeria agriculture through Transformation agenda: The way forward	Moor Plantation, Ibadan	2013
8.	University of Abuja	Emerging issues in Agricultural Transformation in Nigeria	Abuja	2014
9.	Delta State University	Agriculture: The Nigerian Economy beyond Oil	Asaba	2015
10.	National Root Crop Research Institute	Economic Diversification: The agricultural Road map	Umudike	2016

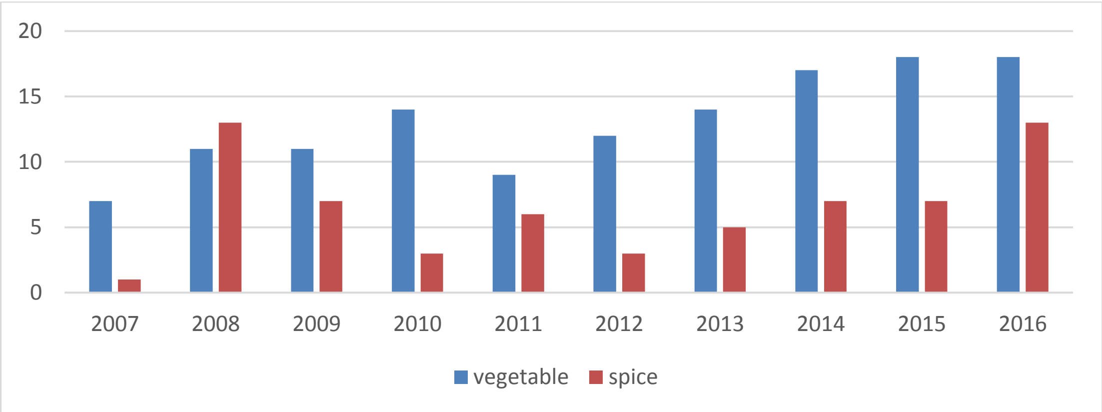

Fig. 1: Vegetable and Spice crops published in ASN Conference Proceedings in ten years

This indicated that vegetables and spices despite its benefits are being ignored in research. There is the need for more research to be carried out on these important horticultural crops. Table 2 shows that the family of Solanaceae recorded the highest researched crop family (5), followed by Cucurbitaceae (3). Crop species of *Abelmoschus esculentus* recorded the highest specie, followed by *Zinger officinale* (300 and *Telfairia occidentalis* (29), while *Lepidium sativum* had the least representation of 1 specie.

Table 2: List of Researched Horticultural Crops Reported in 10 Years ASN Conference Proceedings (2007 – 2016)

Family	Crop Specie	Number of occurrences
Alliaceae (2)	*Allium cepa*	7
	Allium sativum	5
Amaranthaceae (1)	*Amsranthus spp.*	10
Asteraceae (1)	*Veronmia amygdalina*	2
Brassicaceae (1)	*Lepidium sativum*	1
Cucurbitaceae (3)	*Cucumis sativum*	16
	Telfairia occidentalis	29
	Cucurbita pepo	2
Crucifera (1)	*Brassica oleracea*	2
Labiatae (1)	*Ocimum viride*	2
Malvaceae (2)	*Abelmoschus esculentus*	44
	Hibiscus sabdariffa	3
Portulacaceae (1)	*Talinum tringulare*	5
Solanaceae (5)	*Lycopersicon esculentum*	17
	Solanum melongena	8
	Capsicum frutescens	5
	Trichosanthus cucumerina	2
	Capsicum annum	2
Umbelliferae (1)	*Daucus carota*	2
Zingiberaceae (2)	*Zinger officinale*	30
	Curcuma longa	2
12 families	**22 species**	**196**

Figure 2 shows that Universities in Nigeria had the largest representation in the study (4.38%), followed by Research Institutions (2.19%), and followed by Colleges of Agriculture (1.36%). The Polytechnics and Colleges of Education had 0.34% and 0.03%, respectively. The increase in the number of research work on vegetables and spices from the Universities and Research Institutions and Colleges of Agriculture could be attributed to their wide scope of agricultural related courses offered as well as their mandates.

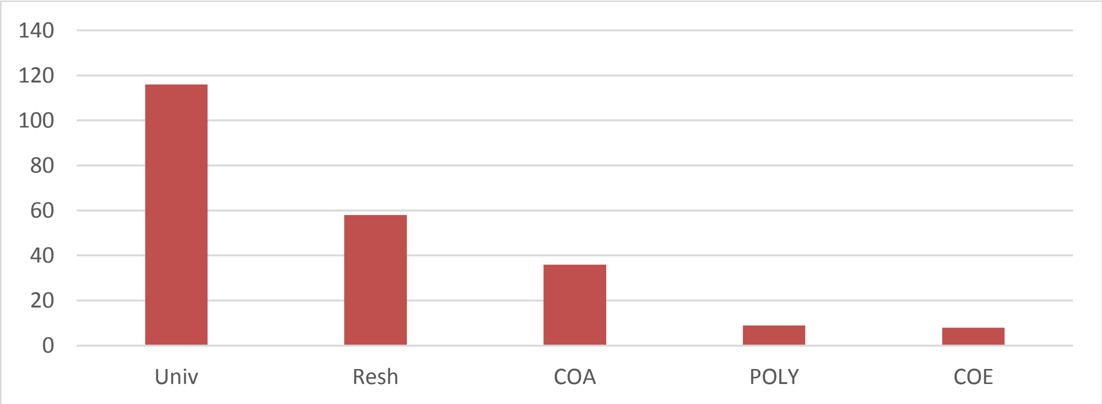

Fig. 2: Vegetable and Spice Crops Published in ASN Conference Proceedings in 10 years by Institutions

Conclusion

This paper examined vegetables and spices research in Nigeria as exemplified in Agricultural Society of Nigeria (ASN) conference Proceedings in a decade publications. There was disproportionate low frequency of publications pertaining to vegetable and spice crops in relation to other aspects of agricultural production. Author's affiliation revealed that Universities in Nigeria have the highest contributions, followed by Research Institutes. Large numbers of research publications within the period were during 2015 and 2016 ASN conferences only. Capacity building of appropriate personnel to steer the much needed development in the industry is imperative and advocated.

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Comparative Analysis of Profitability of Cassava Production in Southern Nigeria

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Abstract
The study compared the profitability of cassava production in different cassava producing states of Nigeria namely Anambra, Ebonyi and Ogun States as first set. Others were Benue, Taraba and Niger States as second set. Primary data used were collected from ninety cassava farmers under International Fund for Agricultural Development (IFAD) with the aid of structured questionnaire. The data were analyzed using profitability and Duncan test models. The results indicated that cassava production is more profitable in second set of States – Benue, Taraba and Niger than in the first. The result further showed no significant difference among Anambra, Ebonyi, Taraba and Ogun, but showed significant difference among Ebonyi, Taraba, Ogun and Niger at 10% and also among Taraba, Ogun, Niger and Benue at 10% levels. It was concluded that cassava production in Nigeria is a profitable venture but labour cost is the major challenge facing the farmers.

Introduction
According to Onyemauwa (2010), cassava has the potential to increase farm incomes, reduce rural and urban poverty and help close the food gap. As a cash crop, cassava generates cash income for the largest number of households, in comparison with other staples, contributing positively to poverty alleviation (Obisesan, 2012). Reports have shown that a higher proportion of cassava farmers, in Nigeria get a higher income from its production more than they get from most of other major staples (Ezeibe, *et al.,* 2015). Okonkwo, *et al*. (2016) noted that cassava would yield higher revenue if cassava farmers are encouraged in areas like loan and credit facilities. Cassava is reported to be grown in 24 of the country's 36 States, but dominates in the southern part of the country, both in terms of area covered and number of farmers growing the crop (Okonkwo and Nwaru 2017). The crop's ability to provide a stable food base and thrive in different parts of the country is a function of its flexibility in terms of planting and harvesting strategies and because of its relative tolerance to poor soil and pests/diseases problems. However, the profit base of cassava farmers would be attributed to different market forces and price differentiation of cassava and its products in different location of the country. Therefore, this study focused on comparing the profitability of cassava production in some selected States of the southern part Nigeria

Methodology
The study was purposively carried out in Anambra, Ebonyi, Ogun, because they are among the six cassava-producing States under the Federal Government of Nigeria (FGN) / International Fund for Agricultural Development (IFAD) and also selected for cassava value chains for sustainable Agriculture. A multi stage random sampling technique was employed in the selection of LGAs and respondents within these States. Eighteen (18) Local Government Areas (LGAs) were selected for the study and from the LGAs, 45 cooperative societies were selected and from each of the cooperatives, one farmer was chosen. Data were collected from the selected farmers with the help of structured questionnaire and this was based on the costs and returns of cassava production. Profitability analysis was analyzed using net income analytical model while the profitability result of each of the States was compared using Duncan multiple range test model.
The models are derived mathematically as follows:

Net Income (NI) = Total Revenue (TR) – Total Cost (TC)
where
TR = cassava output x price in Naira
TC = Total Variable Cost (TVC) + Total Fixed Cost (TFC)

Duncan multiple range test model is as follows:
$DMRp = Qp\sqrt{MSE} / r$
where
DMRp = Duncan Multiple Range
Qp = Shortest Significant range
$\sqrt{MSE}$ = Mean Square Error
r = Number of states
The depreciation method used was the straight line method, which is: (Price of product – Salvage value of product) / Life span of the product. However, it was assumed in this report that the salvage value of the farm tools is zero, since most of the farm tools may not have any useful value after its useful life. This is in line with Dillivan (2014).

Results and Discussion

Profitability Results for One Hectare of Cassava Production in Anambra, Ebonyi and Ogun States

Table 1 shows the estimated profitability results of one hectare of cassava production. The pooled result shows that total cost for the production of one hectare of cassava in the Southern Nigeria was ₦312, 672.82 while the total revenue from the hectare of cassava was ₦487, 288.89. This shows that if a total of ₦312, 672.82 is spent in producing one hectare of cassava, a net income (profit) of ₦174, 616.07 would be realized and this suggests that cassava production in the region is profitable. This agrees with Okonkwo and Nwaru, (2017) who noted that cassava production is profitable to both male and female farmers. Also Obisesan, (2012) noted that cassava as a cash crop, cassava generates cash income for the largest number of households, in comparison to other staples hence contributing positively to poverty alleviation.

Table 1: Estimated Profitability per Hectare of Cassava Production

		Anambra state		Ebonyi state		Ogun state		Pooled	
Activities	**Unit**	**Value (N)**	**% of TC**	**Value (n)**	**% of TC**	**Value (n)**	**% of TC**	**% of TC**	**% of TC**
Clearing	Mandy	30266	10.2	26200	8.98	34393.33	9.81	30286.67	9.68
Stumping	Mandy	16600	5.61	22266.67	7.63	58293.33	16.63	32386.67	9.96
Mound/ridge making	Mandy	34800	11.8	21800	7.47	31293.33	8.93	29297.78	9.39
Cassava stem	Bundle	43803	14.8	63133.33	21.64	26470	7.55	44468.89	14.67
Planting	Mandy	18533	6.27	8600	2.95	13786.67	3.93	13640	4.38
Fertilizer	Kg	27700	9.37	27933.33	9.57	28496.67	8.13	28043.33	9.02
Weeding (3 times)	Mandy	45706	15.56	14000	4.79	28670	8.18	29458.89	9.48
Herbicide	Littre	12627	4.27	15266.67	5.23	12186.67	3.48	13360	4.33
Pesticide	Littre	74813	2.53	10700	3.67	10840	3.10	9673.78	3.10
Transport		11987	4.05	18233.33	6.25	15733.33	4.49	15317.78	4.93
Harvesting	Mandy	21300	7.20	18530	6.35	23100	6.59	20976.67	6.71
Total variable cost (TVC)		270805		246663.33		283263.3		266910.44	
Fixed cost									
Land	Ha	19033.3	6.44	38933.33	13.34	65933.33	18.8	41300	12.86
Depreciation		5,820		6168.23		1399.29		4462.38	
Total fixed cost (TFC)		24853		45101.55845		67332.62		45762.38	
Total Cost (TC) = TVC+TFC		295658		291764.89		350595.96		312672.82	
Output									
Cassava root	Kg	189067		195566.67		533400		306011.11	
Cassava stem	Bundle	143333		218500		182000		181277.7778	
Total Revenue (TR)		332400		414066.67		715400		487288.89	
Net Income TR-TC		36742.4		122301.78		364804.043		174616.07	
Benefit Cost Ratio B/C 0.12	**0.42**		**1.04**		**1.79**				

Source: FGN/VCDP/IFAD, 2017 Survey.

Furthermore Ezeibe, *et al.,* (2015) reported that higher proportion of cassava farmers in Nigeria get a higher income from cassava production than they get from most other major staples. However from the result, high cost of planting material (14.67%) and land acquisition (12.86%) were the major challenges facing the production of cassava in the region. The high cost of planting material and land is an indication that they are in short supply. The scarcity of planting material could be attributed to the infestation of cattle into cassava farm as at the time of the study or that majority of people are now into cassava farming due to the economic recession in Nigeria.
The result indicates that a one Naira invested on cassava production in Anambra and Ebonyi States would yield N0.12 and N0.42 respectively. This is an indication that farmers in Anambra and Ebonyi have low return on investment unlike farmers in Ogun State who could earn N1.04 for every one Naira invested on cassava production. This could mean that there is strong market outlet in Ogun State than Anambra and Ebonyi States. Generally, the pooled result indicated that cassava production would yield N1.79 for every one Naira invested on cassava production in the area under study. This implies that cassava production has the capacity to increase farmers' income and also reduce poverty. According to Onyemauwa, (2010) cassava has the potential to increase farm incomes and reduce rural and urban poverty.
Table 2 shows the comparative results for the profitability of cassava production for the three States in under study.
From the Table, Anambra is not significant different to Ebonyi, and Ogun States while Ebonyi is significantly different at 10% level to Ogun State. The implication of the results is that there are differences in the profitability levels across the States, perhaps due to differences in management decision on sale, level of investment and the use of innovation. The results conform to the earlier study by (Alsyouf, 2004).

Table 2: Duncan Test Analysis

States	Net Income
Anambra	172071.428
Ebonyi	358875.0000
Ogun	700750.0000
p-value of Duncan multiple test analysis	**0.203**

Summary and Conclusion

Cassava production in Nigeria is a profitable venture and that labour cost gives the highest cost incurred by farmers in production. The foregoing, therefore suggested that cassava production in the study areas is a profitable venture that needs to be developed and built upon in Nigeria quest to be food secured and to alleviate rural poverty through cassava seed multiplication. This conforms to earlier studies of Zakari *et al* (2016), Enimu *et al* (2016), Okoh (2016) and Toluwase and Abdu-raheem (2013).

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Constraints Militating Against the Supply of Cocoyam to Consumers in Umuahia North LGA of Abia State

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Abstract

This study was conducted in Umuahia North Local Government Area of Abia State which is noted for farming and trading of cocoyam. Purposive sampling technique was used in selecting Oriendu and Nkwoegwu communities for the study because of high production of cocoyam in the communities. About 30 respondents were selected randomly from each of the communities. Structured questionnaire was used in data collection and data were 96nalysed using descriptive statistics such as frequency distribution, percentage and mean. From the result obtained, female farmers dominate male farmers in cocoyam supply, and farmers within the age range between 40-51 years had the highest percentage in the supply of cocoyam in the study area. The result also showed that 80% of the respondents had formal education. Constraints encountered by the respondents were mainly lack of fund (22.98%) followed closely by lack of access to land (19.70%). This is expected because women are mostly involved in cocoyam production. Polices should be advocated in the areas of granting soft loans to the women to rent land to increase cocoyam production in the study area since lack of land is also one of the major challenges faced by the respondents.

Introduction

Cocoyam (*Xanthosomana maffafa* and *Colcocasia esculanta*) is one of the major tuber crops in which Nigeria is the largest producer in the world, producing about 5.39 million metric tons per annum (FAO, 2008 and 2009). Nigeria accounts for an average production figure of 37 percent of total world output of cocoyam, but the average production rate is still low. Two major species of cocoyam, cultivated in Nigeria are *Xanthosoma maffafa* and *Colcocasia esculanta*. The production of cocoyam in Nigeria however, had stagnated in the last few decades due to several production constraints among which are various pre-harvest and postharvest challenges (Nwakor *et al;* 2015). The average yield has remained relatively low ranging between 5.0 and 7.5 tons/ha in Nigeria. The discrepancy is a clear indication the current yield of cocoyam is currently far below its potential yield of 15-20 tons per hectare in farmers field (Onyeka, 2014). There is problem of diseases including the taro, leaf blight caused by fungi *phytophoraclocasine*. The cultivation of cocoyam in most African countries including Nigeria is essentially in the hands of resource poor farmers with minimum input (NRCRI, 2011). Okoye *et al*. (2009) established that cocoyam have yield potential of 30-60 tons per hectare which indicates that there is much room for improvement on the farmers output through research and development of the crop. Cocoyam is grown extensively in the eastern States but it does best in places with high humidity, good water supply and good soil throughout the growing period (Okereke *et al*, 2009). Before the civil war, Imo State was the largest producer of cocoyam in South-eastern Nigeria, but now the output of this crop has declined (Eze and Okorji, 2003). The management practices of the past are no longer in use in the cocoyam growing communities as supposed, due to emphasis on modern agriculture, yet the output decline of cocoyam has continued to decline in the face of modern technologies. High cost of labour, poor extension of modern agricultural technologies and many other factors may have contributed to the poor output of cocoyam in the recent years. The demand for cocoyam has continued to increase with increase in population. In spite of considerable increase in hectare cultivation of the crop so as to increase the output, yet the poor average yield of about 170,000 tons per annum continue to prevail (Ohajianya, 2005). It was against the background that it becomes imperative to assess constraints militating against the supply of cocoyam to consumers in Umuahia North Local Government Area of Abia State.

Methodology

This study was conducted in Umuahia North Local Government Area of Abia State which is noted for farming and trading of cocoyam. Purposive sampling technique was used in selecting Oriendu and Nkwoegwu communities for the study because of high production of cocoyam in the communities. Thirty respondents were selected randomly from each of the communities. Structured questionnaire was used in data collection from primary source and data were analyzed using descriptive statistics such as frequency distribution, percentage and mean.

Results and Discussion

Socioeconomic Characteristics of the Respondents

The results in table 1 show the socioeconomic characteristics of the respondents. It indicates that there were more females (76.7%) than males in cocoyam production than males. Women are the custodian of cocoyam farming in most African countries, thus improving cocoyam production should have a direct impact on the most economically vulnerable groups (Onyeka, 2014).

Table 1: Socioeconomic Characteristics of the Respondents

Variables	Frequency	Percentages
Sex		
Females	46	76.7
Male	14	23.3
Total	60	100
Age		
21-30	2	3.3
31-40	10	6.7
41-50	28	46.7
51-60	14	23
71 and above	4	6.7
Total	60	100
Marital Status		
Married	40	66.7
Widowed	15	25
Single	5	8.3
Total	60	100
Religion		
Christianity	57	95
Traditional	3	5
Total	60	100
Level of education		
No education	15	25
Primary education	25	41.7
Secondary	16	26.7
Above secondary	4	6.7
Total	60	100
Household size		
1-4	6	10
5-8	40	66.7
9-12	12	20
13 and above	2	3.3
Total	60	100

Source: Field survey, 2014.

Most of the respondents were married (66.7%) while (95%) were Christians. About 42% had basic education. The result also showed that 47% of the respondents were within age range of 41-50 years which implies that the respondents were within the productive and active age. Majority

(81.7%) of the respondents were literates. This agrees with the findings of Agbanu and Atoma (2010) that level of education influences participation in agricultural productive activities, adoption Transfer and application of innovations.

Problems Faced by Cocoyam Producers in the Study Area

Table 2 shows the constraints encountered by the respondents. The most common problem was lack of fund (22.98%), followed by access to land (19.70%). This is expected because women are mostly involved in cocoyam production. Some areas in the South east, women do not have access to land. Other constraints were high cost of fertilizer (16.50%), lack of extension contact (14.89%), pest and diseases (13.59%) and bad road network (6.79%). The least constraint is high cost of labour (5.59).

Table 2: Problems faced by cocoyam producers in the study area

Constraints	Frequency	Percentage
Lack of fund	71	22.98
Lack of access to land	61	19.70
High cost of fertilizer	51	16.50
Lack of Extension contact	46	14.89
pest and Diseases attack	42	13.59
Bad road network	21	6.79
High cost of labour	17	5.59

Source: Field survey, 2014
*Multiple responses accounted for this number

Conclusion

The study revealed that more women are involved in cocoyam production that fall within active production age. The respondents (cocoyam farmers) are constrained by many factors which include lack of fund and land among others. Polices should be advocated in the areas of granting soft loans to the women to rent land to increase cocoyam production in the study area since lack of land is also one of the major challenges faced by the respondents.

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Consumers' Willingness to pay for the Primary Products of Maize in Aba Agricultural Zone of Abia State, Nigeria

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Abstract
The study analysed varieties and primary products of maize supplied, and willingness of consumers to pay for them in Aba Agricultural zone of Abia State, Nigeria. The specific objectives include to identify the varieties and primary products of maize supplied to consumers in Aba Agricultural zone of Abia State; estimate consumers' willingness to pay for maize; and determine factors that influenced demand for maize in the study area. Data generated from survey of consuming stakeholders were subjected to descriptive analysis, consumer willingness to pay estimation and probit regression analyses. The demand for maize was influenced by size of household, number of feed millers in the area, and price of rice (close substitute to maize). There was good market for maize as consumers on the average were willing to pay a price not more than ₦125.00 per kilogramme weight. We recommended that traders should supply more maize and local farmers increase own production to help bring down maize price and further enhance it.

Key Words: Maize, own production, willingness to pay, demand

Introduction
Maize (*Zea mays, L.*) is the most important commercial cereal in the World after wheat and rice on which many agro-based industries depend for raw material (Iken and Amusa, 2004). Different varieties of maize with unique grain structures and colours are supplied in local markets and are purchased by processors and consumers for food, livestock feed and other industrial uses. Matured green maize are cut fresh on the cobs and sold to consumers who eat them as roasted, parched, baked, or boiled nutritious delicacies that help in quenching hunger. Maize is rich in carbohydrate (80.0%), protein (10.0%), fibre (3.5%), minerals (2.5%) and vitamin B and oil (4.0%) on dry weight (IITA, 2001).The primary products of maize include pap, flour, moimoi; *agidi* and popcorn consumed as food or used as raw material in pharmaceuticals.

A consumers' willingness to pay for a commodity shows the monetary value he attaches to the commodity. His willingness to pay for one more unit of the commodity actually is the monetary measure (naira or dollar) of the benefits the extra unit of the commodity gives him. This otherwise is the marginal benefit derivable from the commodity. It gives a guide that could help estimate actual commodity price in the market. This price of the commodity will be at a point somewhere between the buyer's willingness to pay and trader's willingness to accept. For maize, it is a maximum price at or below which maize consumers definitely will buy one unit of maize package. Consuming households, individuals, processors and even farmers who buy maize as planting material make effective demand for it and its primary products (Nwaigbo, 2011). They all need to be supplied with adequate stock of maize according to their choice in our local markets within determinable range of prices. To achieve this, it becomes imperative to specifically: (i) identify varieties, forms and primary products demanded by consumers in Aba Agricultural zone of Abia State;(ii) estimate consumers' willingness to pay for maize in the area; and (iv) determine factors that influence demand for maize in the study area.

Materials and Methods

This Study was carried out in Aba agricultural zone of Abia State Nigeria. Aba Agricultural zone is one of the three agricultural zones in Abia State. The constituent LGAs of the zone are Aba North, Aba South, Ugwu-na gbo, Ukwa East and Ukwa West. Amongst these LGAs, Ukwa West and Ukwa East are essentially rural and agrarian with the other three being cosmopolitan and host many industries, households and individuals consume maize and its primary products.

Stratified random sampling was used in selecting respondents. The respondents were from the strata of housewives, street buyers, feed millers/industrialists and farmers. Four respondents on each of the four strata were chosen at random from each of the five constituent LGAs. This gave a sample of 80 maize users involved in this study.
Data were collected on variety/form of maize and primary products demanded by buyers (green cobs, roasted and dry cobs/maize grains, pap (*akamu*), and *agidi*). The data collected were presented descriptively in a frequency distribution Table. The demand factors for maize were estimated with the following Probit regression demand model:

$$Y= \alpha + \beta_1 X + \beta_2 B + \varepsilon \quad (1)$$

Where
Y= Bought maize (yes=1), did not buy maize (no=0);
B = Bid price or Price of a unit form (fresh/dried cob/grain) of maize bought (₦);
X_1= Price of one Kg of rice as close substitute (₦);
X_2= Household size (number);
X_3= Number of livestock feed industries known around by respondent (number);
X_4= Monthly income used for maize/product(s) purchases (₦'000);
εi= Error term.

Mean Willingness to Pay (MWTP) was derived from the expression $((\sum(\beta_1 * X^a)/\beta_2)^{*}\text{-}1 \quad (2)$
X^a = Mean value of the X variables

It is true that maize is a commodity traded at a price, but veracity of its forms and products and the fact that farmers in the area consume much of own products, necessitates that we estimate its economic value. The willingness to pay was thus estimated with model of consumer willingness to pay.

Results and Discussion

Maize Varieties and Primary Products Purchased

Table 1 shows maize varieties/forms and primary products of maize by types of buyers in Aba Agricultural zone of Abia state Nigeria. The Table revealed that respondents consumed maize in fresh green cobs; dry white cobs; dry yellow cobs; roasted, boiled, or as prepared into pap, flour, moi-moi; *agidi* and popcorn by housewives (25.0%), farmers (25.0%) and street buyers (35.0%). These consumers and members of their households ate maize to derive from the rich vitamin A, C and E, carbohydrates, dietary fibre, sulphur amino acid, and about 9.0% protein present in it(IITA, 2001; Khawar *et al.* 2007).Farmer consumers of maize feed on the maize and use the carefully selected viable seeds as planting material on their plots. The millers/livestock feed producers constituted 15.0% of the maize buyers who bought maize mainly as whole yellow grains, flake grits, and flour. The maize grits are the larger pieces of broken maize endosperms freed of husk and germ which they used as feed stuff.

Table 1: Distribution of Maize varieties/forms and primary products of maize by types of Buyers in Aba Agricultural zone of Abia state Nigeria

Type of Maize Buyer	Variety/Form/Primary Product of Maize bought	Number of Buyers	Percentage
Housewives	Green cobs; dry white cobs; dry yellow cobs; pap, flour, moi-moi; pop corn, *agidi*,	20	25.0
Street buyers	Roasted maize cobs; boiled maize cobs, Pap, flour, moi-moi, pop corn, *agidi*,	28	35.0
Feed millers/ industrialists	Whole yellow grains, Isolo (yellow), Ns-1 (yellow), Western yellow 1096BP6 (yellow), flake grits, and flour.	12	15.0
Farmers	Whole grains, dry cobs, pap, flour, moi-moi, pop corn, *agidi*, Bende local (white), TZPB (white), TZB (white)	20	25.0
Total		**80**	**100.0**

Source: Field Survey, 2016.

Willingness to Pay for Maize

The consumer's willingness to pay for one unit of maize is his derivable marginal benefit from the commodity. Willingness to pay and Marginal benefit are thus the same and can thus to be used interchangeably. Precisely, the willingness to pay is the maximum amount of money an individual is willing to hand over to procure a product or avoid something undesirable (Table 2.0). The Table shows that maize consumers in the study area were willing to pay any price less than ₦125.00 per kilogramme since the mean WTP was ₦124.460.00.

Table 2: Probit estimates of determinants of consumers' willingness to Pay (WTP) for Maize

Variable	Coefficient	Mean	Coefficient * Mean
Mean price of maize forms (B)	-0.7023		
Unit (kg) price of rice	0.0322	147.215	4.740323
Household Size	0.8571	7.211	6.1805481
Number of known feed Industries/millers	4.112	5.612	23.076544
Income spent on Maize	0.005	4,200.00	21.000
Constant	32.411		32.411
Total			**87.4084151**

Source: Field Survey, 2016.

Mean WTP= (87.4084151/-0.7023) *-1 = 124.46022369

Demand for Maize

The factors that influenced quantity of Maize bought by units consuming maize were estimated with Probit Regression estimates as shown in Table 3. The demand for maize was very highly determined by population of the consumers' proxies by size of households. Other factors that influenced its demand in descending order were number of feed millers in the area, mean price of maize forms and unit price of rice (close substitute to maize).

Table 3: Probit Regression Estimates of Factors Influencing Demand for Maize

Variable	Coefficient	t-ratio
Constant	32.411***	8.92
Mean price of maize forms (B)	-0.7023*	-1.90
Unit (kg) price of rice	0.0322*	1.99
Household Size	0.8571***	4.98
Number of known feed Industries/millers	4.112**	2.62
Income spent on Maize	0.005	0.35
Pseudo R^2	0.766	
Chi Squared	12.02***	

Source: Field Survey, 2016. Significance at alpha levels of 1%***; 5% **; and 10% *.

Conclusion and Recommendations

There was a good market for maize in Aba Agricultural zone of Abia State, Nigeria. Maize consumers in the study area were on the average willing to pay any price less than ₦125.00 per kilogramme. To meet the demand for maize without tolerating gaps in its supply, we recommended that traders should buy more maize from areas of maize production in the country. In addition, the local farmers should strive to increase maize yield to help increase supply of more maize and bring down the price. This will further enhance the demand for maize.

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Constraints Facing Male and Female Households in Ware Yam Marketing in Abia State, Nigeria

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Abstract
The study analyzed constraints facing male and female households in ware yam marketing in Abia State, Nigeria. Multi stage random sampling technique was employed in the selection of 120 female and male ware yam sellers from twelve community yam markets in the area. The tool used for data collection was a structured questionnaire and descriptive statistics was used in realizing results. The result showed that 61.67% of the household heads had between 1 and 5 persons in their households. With respect to constraints, transportation cost was the most common constraint as 95.00% of female-headed households and 88.33% female-headed households confirmed it. To sustain strategies for enhancing food security and livelihoods in Nigeria, it is recommended that adequate transportation facilities should be provided by the government and the ministries of agriculture, especially in the rural areas where the produce are being produced, for ease of movement of the produce.
Keywords: Households Heads, Ware Yam, Constraints, Yam Marketing

Introduction
Ware yam is a primary agricultural commodity in Nigeria. It is the big sized and the marketable yam. The tuber can grow up to 2.5 meters in length and weigh up to 70kg (150 pounds). Depending on variety, its flesh may be of various shades of off-white, yellow, purple or pink, and the skin from off-white to dark brown. The tuber has a rough skin which is difficult to peel, but which softens after heating (Walsh, 2003). Its importance requires that it should be available all through the year, but regrettably, there is a problem of glut in supply of yam at the harvest period and scarcity thereafter leading to high cost of the produce at off season. Supply shrinks as scarcity lasts and this leads to decline in the incomes of men and women in the marketing process (FAO, 2006). Ware yam marketing is of considerable importance in the food economy/security of Nigeria. Ware yam is a major source of cash income to the producer and marketer irrespective of scale of operation. It is very important in local commerce in Africa and accounts for about 32 percent of farm income earned from crops as a source of foreign exchange (Chukwu and Ikwelle, 2002). The importance of ware yam cannot be over emphasized (Igwe *et al*, 2006). The activities of marketing of ware yam in Abia State involve both men and women and the activities involve various exchange points (markets) and the number of exchange points depends on the distance between the yam production and that of consumption. Interestingly, women's involvement in ware yam marketing is gradually increasing. Selling of foodstuffs is seen as a work mainly for women, and most of these women have built up businesses from trading of foodstuffs. Some of these women go to rural rotating markets to buy these foodstuffs and sell at the street side tables (IITA, 2004; Madueke, 2007).
Marketing appears to be the crux of the whole food and agricultural problems (Nwachukwu *et al*., 2007). Ware yam marketing is probably fraught with several macro and micro-economic problems which hinder its efficiency in distribution (Igwe *et al*, 2006). In Abia State, ware yam is becoming more expensive and relatively unaffordable as production has not kept pace with population growth leading to rise in price of the available ones. The State still depend on the northern Nigeria and other south-eastern States for its yam supply since local production is not enough to feed its

populace. A lot of problems such as high transportation cost, theft, perishability, and others, militate against moving this product from the points of production to consumption areas. This affects the final price, quality and income (IITA, 2007). In most south-eastern States of Nigeria, yam production and marketing is seen as men's business because of the energy requirement in its farming activities as well as in its trade. Nowadays, many people are after the white collar jobs, and there has been neglect in yam production (farming) and distribution (marketing) as it is seen as the un-educated and rural people's career (Okwuokenye, 2006). The study therefore analyzed constraints facing male and female households in ware yam marketing in Abia State, Nigeria

Materials and Methods

The study was conducted in Abia State, Nigeria. Abia is in south eastern Nigeria. It is located within latitudes 4^0 45' and 6^0 07' North and longitudes 7^0 10' and 8^0 10' East. It is bounded on the north and north east by Anambra, Enugu and Ebonyi States. To the west is Imo State, to the east and south east are Cross River and Akwa Ibom States, and to the south is Rivers State (Independent National Electoral Commission, 2008). There are three agricultural zones in Abia State, namely Aba Zone, Umuahia Zone and Ohafia Zone (Abia State Planning Commission, 2001).

Multistage random sampling technique was employed. In the first stage, two agricultural zones, Aba and Umuahia were randomly selected. Secondly, four Local Government Areas (LGAs) were selected across the two zones, and three markets from three communities were selected from each Local Government Area from which five female-headed and five male-headed households ware yam marketers were selected to give a total of 120 ware yam marketers for the study.

The researchers collected data with the aid of a structured questionnaire. Data collected include socio-economic characteristics of the respondents and the constraints of ware yam marketing. Descriptive statistics was used to analyse the data.

Results and Discussion

Socio-economic Characteristics of Ware Yam Marketers in Abia State

The socio-economic characteristics of the respondents is shown in Table 1. The table revealed equal number of men and women in ware yam marketing. This is purposive in order to give both gender equal opportunities for participation. This result does not agree with the opinion of Tewe (2002) that men look down on agricultural commodity marketing as petty trade meant for women. About 16.67% of the traders had household size of 11 persons and above. Few (21.67%) had fewer years of experience. This implied that people with little or insufficient ware yam trading experience were discouraged from going into the trade since they were likely to encounter a lot of risks associated with the trade. This agrees with Awoniyi and Omonona (2006) that experienced ware yam traders have higher bargaining power than new entrants. Majority (85%) of the marketers earned less than ₦8,000 per heap of ware yam sold, and this suggests that they were low income earners. The reason could be that most of the traders depended on the ware yam supplies from the northern part of Nigeria whose prices are exorbitant due to the inbuilt transportation expenses.

Table 1 Distribution of ware yam marketers in terms of socio-economic characteristics

Variables		**Frequency**	**Percentage (%)**	**Mean**	**Std. Deviation**
Sex:	Male	60	50.00		
	Female	60	50.00		
Household Size (Number):	1-5	74	61.67	5.2	1.83
	6-10	26	21.67		
	11 and above	20	16.66		
Trading Experience (Years):	1-10	26	21.67	15.5	3.94
	11-20	49	40.83		
	21 and above	45	37.50		
Profit Realized per Heap (₦):	6000-6900	53	44.17	7950	89.16
	7000-7900	49	40.83		
	8000-8900	13	10.83		
	9000 and above	5	4.17		
Total		**120**	**100.00**		

Source: Field Survey; 2012.

Constraints encountered by male and female household heads in ware yam marketing

Constraints encountered by male and female household heads in ware yam marketing is shown in Table 2. Transportation cost was the most common constraint as 95.00% of female-headed households and 88.33% female-headed households confirmed it. This may be due to inadequate transportation facilities in most rural areas in Abia State where motorable roads are lacking, and the available ones are in state of disrepair. This constraint affected the female household heads more (95.00%) than the male household heads (88.33%) due to the fact that men can afford to use head-loads and wheel barrows in transporting their goods unlike women (Echebiri and Mejeha, 2004). Losses in transit accounted for the second highest constraint to household heads' ware yam marketing in Abia State. This is because some ware yams were damaged in the distribution system and also as a result of other activities involved in distribution system such as loading, off-loading and transportation before reaching the final consumer. Inadequacy of funds was another constraint in ware yam marketing in the area. This implied that majority of ware yam traders in Abia State, Nigeria had little funds for the business. This might be as a result of their high dependency on personal savings, funds from friends and relatives (Awoniyi and Omonona, 2006). Perishability of ware yam tubers was ranked as the third and fourth most common constraints to ware yam marketing in male and female-headed households respectively. This may be as a result of low storability and low sales of ware yam in Abia State. Nze (2008) equally confirmed that low sales and storability of yams lead to high perishability. Seasonality constituted the least constraint in thearea. This might be because, although seasonality creates surplus at the harvest periods which must be sold at low prices leading to low income, a large amount of the produce is still available during the off-season (Nze, 2008).

Table 2. Constraints to Gender household heads in Marketing of Ware Yam in Abia State

	Female Household Heads			Male Household Heads		
Constraints	*Frequency	Percentage (%)	Rank	*Frequency	Percentage (%)	Rank
Transportation Cost	57	95.00	1st	53	88.33	1st
Losses in Transit	55	91.66	2nd	49	81.67	2nd
Inadequacy of Funds	48	80.00	3rd	43	71.67	4th
Perishability	33	55.00	4th	47	78.33	3rd
Inadequate Storage Facilities	29	48.33	7th	36	60.00	5th
Lack of Bank Credit	31	51.67	6th	24	40.00	6th
Tenancy/Storage Cost	32	53.33	5th	18	30.00	7th
Seasonality	22	36.67	8th	16	26.67	8th

Source: Field Survey; 2012.
*Multiple responses recorded

Conclusion and Recommendations

Ware yam marketing is a low-income yielding business, as a heap (100 tubers) of ware yam gives only ₦9,000 as profit, and transportation cost is a very big constraint challenging the business for men and women alike. Based on the findings, the researchers recommended that adequate transportation facilities should be provided by the government and the ministries of agriculture, especially in the rural areas where the produce are being produced and marketed. This will entail the construction, expansion and maintenance of urban-to-rural, rural-to-rural and rural-to-urban roads. Government should put up effective transportation schemes, such as good rail ways, roads, etc., that can assist in reducing the cost on transportation by ware yam marketers.

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Evaluation of Wealth Status of Rural Farm Households in Abia State, Nigeria

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Abstract
The study evaluated the wealth status of rural farm households in Isiala Ngwa North Abia State, Nigeria. Random sampling technique was adopted in the selection of sixty farm households in the area and a questionnaire was used in gathering data from the households. Data were analyzed with descriptive and inferential statistical tools. Results revealed that most (38%) of the respondents saved little, below ₦11,000.00 per year, very few (2%) earned between ₦200,001.00 – ₦300,000.00 per year, and majority (74%) spent below ₦50,000.00 on monthly basis. Regression result showed that age, household size, savings, credit amount, years of farming and expenditure were the major factors affecting wealth status. The study also found that the wealth status of farm households could be improved through so many ways such as the use of improved farming implements and infrastructures, availability of accessible roads and transport facilities, availability of credit facilities, etc. It was recommended that farmers should device means of increasing savings like forming savings groups and participating in credit and thrifts societies.
Keywords: Wealth Status, Rural Farm Households and Isiala-Ngwa Abia State.

Introduction
Wealth status is one of the most important variables in social science research because it plays a significant role in the planning and execution of development programs (Tiwari *et al*, 2005). Wealth is the accumulation of resources (Agesa, 2005; Bellon, 2001). Rural farmers are said to be wealthy when they are able to accumulate many valuable resources such as improved seedlings, farming tools/ machine, to mention but a few. A rural household's wealth status could mean the ranking of household in the milieu, to which it belongs, in respect of defined variables, like physical assets such as land, warehouse / storage facilities, farm inputs and outputs, economic status, education, occupation, social position, political influence, caster, among others (Tiwar, *et al,* 2005). The traditional approach to measurement of household wealth status has been through the use of standardized household interview surveys (Worrall *et al*, 2003; Akanke and Atkinson, 2002). An alternative has been the possession of properties such as agricultural lands, building and other valuable assets as proxy for income and expenditure. In Isiala-Ngwa North Local Government Area of Abia State, wealth status is determined based on the accumulation of valuable asset such as labour availability, money to expend on purchasing inputs such as seedlings, fertilizers, herbicides, pesticides etc., investment decisions, and amount used in growing crops. It also includes the number and variety of animals a livestock farmer could keep, as well as, their management tactics which should be used in farming.

However, farmers in Isiala-Ngwa North are currently faced with problem bordering on inadequacy of lands for cultivation of crops and rearing of animals. Other problems associated with the wealth status of rural household in Isala-Ngwa North include lack of access to most basic social amenities such as electricity, well and motor able roads, good water supply, lack access to improved varieties of farm inputs, inadequacy of financial institutions in the rural areas for farmers to save money generated from the sales of their farm produce, etc. High level of illiteracy among the farmers has also led to the inability of rural farmers to apply modern farming techniques in their production processes. The consequences of these have brought about low production of crops and productivity by farm animals. Furthermore, Nigerian performance in the agricultural sector in recent times especially in the rural area suggests that farmers are yet to absorb most of the

mechanized ways of farming due to inadequate credit facilities such as bank loans which could be used in importing machines, improve seedlings to mention but a few.
The study therefore evaluated the wealth status of rural farm households in Isiala Ngwa North Abia State, Nigeria. The specific objectives include examining the wealth profile of the farm households in the study area, determining factors influencing the wealth status of the rural farmers, and ascertaining the possible ways of improving the wealth status of the rural farmer's household.

Methodology

The study was conducted in Isiala-Ngwa North Local Government Area of Abia State, Nigeria. Its headquarters is at Okpuala-Ngwa approximately 30 kilometers away from Umuahia town the State Capital (Census, 2006). It is made up of seven towns which include Ngwa Ukwu, Ama-Asa, Umuohia, Ihie, Amasa-Ntigha, Amapu-Ntigha and Nsulu. The main occupation of Isiala- Ngwa people is farming. The major food crops grown by Isiala-Ngwa people includes cassava, yam, maize, melon, local beans and various vegetables and the cash crops grown under plantation include oil palm, plantain and banana. Piggery, poultry, sheep, goat and fishery form the major livestock enterprise in the study area. The agricultural production is mainly on a small scale.
Six communities were purposively selected based on proximity and accessibility. These communities included Amaorji, Abayi, Eziama-uratta, Ikputu, Umuosu and Mbawsi, and 10 farmers were randomly selected from each community with the use of questionnaire which contained information on their household wealth status among others to give a total of sixty respondents for the study. Data collected were analyzed using both descriptive and inferential statistical tools. In realizing objectives 'i' and 'iii', descriptive statistics such as tables, frequency distributions and percentages were used. Objective 'ii' was analyzed using ordinary least square regression.

Model Specification

The regression model that explained the factors influencing wealth status of rural farm households was implicitly stated as; $\mathbf{Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, e)}$

Where;

Y	=	Wealth status of respondents proxied by the value of farm assets (₦)
X_1	=	Age of respondent in (years)
X_2	=	Household size (number of persons living in a household)
X_3	=	Years of education (Years)
X_4	=	Average family monthly savings (₦)
X_5	=	Credit amount (₦)
X_6	=	Amount of interest (₦)
X_7	=	Years of experience in farm business (years)
X_8	=	Average household monthly expenditure (₦)
e	=	Error term

Results and Discussion

Wealth profile of rural farm households in Isiala-Ngwa North Local Government Area of Abia State, Nigeria

The wealth status of the rural farm households in Isiala-Ngwa North Local Government Area of Abia State, Nigeria is shown in Table 1. The **t**able showed that majority (60.0.0%) of the rural farm households in Isiala-Ngwa North's average income was below ₦51,000, while only 8.3% had an average income of ₦300,000 and above per month. This implied that most of the farmers in the study area were very low income earners. Few of the respondents (13.3%) saved above ₦55,000, 11.7% saved within the range of ₦41,000- ₦55,000, and majority (38%) saved below ₦11,000 on monthly bases. This implied that farmers saved little. Majority (33.3%) obtained credit of below ₦51,000 while only 8% of them obtained credit of ₦200,001 and above. The implication is that these households do not rely on much credit for their sustainability, and this is plausible. Majority (74%) of the respondents' monthly expenditure was below ₦50,000 in a month. The implication is that the monthly expenditure of these farmers is low and this can help to increase the wealth status and encourage the farmer to invest more capital into the farming business.

Table 1: Distribution of respondents according to their wealth status

Wealth status	Frequency	Percentage
Average monthly income		
Below ₦51,000	36	60.0
₦51, 000 – ₦100,000	10	16.6
₦100, 001 – ₦200,000	6	10.0
₦200, 001 – ₦300,000	3	5.0
₦300, 001 and above	5	8.3
Monthly savings		
Below ₦11,000	19	31.6
₦11,000 – ₦25,000	10	16.7
₦26,000 – ₦40,000	16	26.7
₦41,000 – ₦55,000	7	11.7
₦56,000 and above	8	13.3
Credit amount		
Below ₦51,000	20	33.3
₦51,000 – ₦100,000	17	28.3
₦100,001 – ₦200,000	6	10.0
₦200,001 – ₦300,000	11	18.3
N300,001 and above	6	10.0
Amount of interest (N)		
Below ₦10,000	15	25.0
₦10,100 – ₦300,000	20	33.3
₦30,001 – ₦60,000	15	25.0
₦60,001 – ₦90,000	0	0.0
Above ₦90,000	10	16.7
Average monthly expenditure (N)		
Below ₦50,000	37	61.7
₦50,100 – ₦150,000	9	15.0
₦150,001 – ₦300,000	8	13.3
₦300,001 and above	6	10.0
Total	**60**	**100**

Source: Field Survey; 2016.

Factors influencing wealth status of the rural farm households

Regression result on factors influencing wealth status of rural farm households is shown in Table 2. Age, household size, savings, credit amount, years of farming and expenditure were all statistically significant at different levels of probability with different signs. The coefficient of age (113638.929) was significant at 1% level of probability and positively related to wealth status of rural farm households. This implied that older farmers were wealthier than younger farmers. This conforms to *a priori* expectation as higher age must have led to accumulation of wealth. Household size was also significant at 1% level of probability and positively related to wealth status. This means that the higher the number of people in the household the higher the wealth status, because the amount of money spent in hireling farm labor could be saved by using members of the family as farm labor. Saving was significant at 10% level of probability and positively related to wealth status. The implication is that high savings encouraged high wealth status. Credit amount was significant at 1% level of probability and positively related to wealth status, thus implying that higher farm households' access to credit increased their productivity which in turn improve their wealth status. Years of farming experience was significant at 1% levels of probability with a positive sign which implied that the more farm households stay in the farming business, the more experienced and tactical they become and the resulting outcome will increase the family wealth status. Expenditure was significant at 1% level of probability and negatively related to the wealth status, implying that an increase in the household's expenditure reduced their wealth status. This conforms to *a priori* expectation because the higher the expenditure, the lower the savings.

Table 2: Regression result on factors influencing wealth status of rural farmers in the study area

Parameters	Coefficient	Standard error	T-values
Constant	1.142E6	1.574Eb	0.726
Age	113638.929	30186.444	3.7653***
Household size	1.129E6	254814.673	4.430***
Years of education	54705.977	61651.205	0.887
Savings	31,533	17.133	1.840*
Credits amount	27.605	2.902	9.511***
Amount of interest	22.612	16.475	1.372
Years of farming	271484.316	70949.050	3.826***
Expenditure	35.108	4.765	-7.367***
R^2	0.994		
R^{-2}	0.943		
F-ratio	19.586***		

Sources: Field Survey; 2016.
Note: *** = Significant at 1%, ** = Significant at 5% and * = Significant 1%

Ways of improving wealth status of rural farmers' household
From Table 3, 27.35% of the respondents indicated that for rural farm households to have sustainable strategies for enhancing livelihoods the use of improved farming implements and infrastructures should be adopted to reduce low productivity and remove tedious activities found in agriculture while 17.96% of the respondents suggested that there should be accessible roads and transportation facilities. About 16% of the respondents indicated that if credit facilities and financial institutions should be accessible that it will increase their wealth status, and 13.06% of the respondent suggested that planting of improved seedlings will help to increase productivity.

Table 3 Distribution of respondents' response on possible ways of improving wealth status

Ways of improving wealth status	Frequency	Percentage	Rank
Improved farming implements and infrastructures	57	27.35*	1st
Accessible roads and transport facilities	44	17.96*	2nd
Accessibility of credit facilities and savings	39	15.91*	3rd
Crop improvement and improved seedling	32	13.06*	4th
Reduction in farm input cost	17	6.94*	5th
Nearest to market	10	4.08*	6th
Animal health and vaccines	7	2.86*	7th
Land expansion	7	2.86*	7th
Improvement of soil fertility	6	2.45*	8th
Increase workforce	5	2.04*	9th
Investment	5	2.04*	9th
Crop protection and availability agrochemicals	3	1.22*	10th
Irrigation system of farming	2	0.82*	11th
Agricultural trainings	1	0.41*	12th

Source: Field Survey; 2016.
* = Multiple response recorded

Conclusion and recommendation

Based on the findings of the study, rural farm households in Isiala Ngwa North, Abia State are very low income earners, and they equally spend low on monthly basis. Household size, income, savings, household monthly expenditure influenced their wealth status which could be enhanced through the use of improved farm implements and infrastructures. It is recommended that farmers should device means of increasing savings like forming savings groups and participating in credit and thrifts societies; modern farm equipment should be provided for the local farmers and that government should help in making credit easily accessible to the rural farm householders to enable their embrace the modern ways of farming that will lead to greater productivity and hence improve their wealth status.

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Analysis of Inorganic Fertilizer Use on Sesame Production in Awe Local Government Area of Nasarawa State, Nigeria

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Abstract
The study examined inorganic fertilizer usage among sesame farmers in Awe local government Area of Nasarawa State, Nigeria. A purposive sampling procedure was used to select a total of 80 sesame farmers. Data was collected with the aid of a questionnaire. The result showed that 65.5% of the respondents cultivate sesame as a sole crop while 34.5% cultivate it as a mixed crop. The result revealed that 65.5% of the respondents do not apply inorganic fertilizer to sesame while 34.5% applied inorganic fertilizer to the Crop. The mean quantity of the respondents apply NPK and urea fertilizer were 6.5bags/ha and 3.7bags/ha respectively. The result further showed that the regression coefficients of farm size were significant at 1%. The R^2 *value was 0.7899 indicating that 78.99% of the variation on inorganic fertilizer was used in sesame production. The major source of fertilizer application information is by radio. the research concluded by calling on extension agents to create awareness to sesame farmers in the study area through establishment of Small Plot Adaptive Technique (SPAT) by demonstrating sesame respond to inorganic fertilizer.*

Introduction
Fertilizer use is crucial for sustainable intensification and for raising farm productivity under increasing land constraints and decline soil fertility. Fertilizer is one of the critical inputs used in improving smallholder food and agricultural productivity. Trends in fertilizer use are very important because without significant increases in the use of chemical fertilizers it will not be possible for the production of sesame to keep up with the demand from a rapidly growing population and agro-industries. Traditionally Nigeria farmers have been using fertilizer primarily on commercial/export crops, but in recent years, an increasing quantity of fertilizers is being used on such food crops as rice, maize, wheat, Yams, Cassava and sesame (RMRDC Survey 2004).
Sesame (*Sesamum indicum L.*) belongs to the family *Pedaliaceae.* The genus consists of about thirty six species of which the most commonly recognized is *Sesamum indicum L.,* popularly known as beniseed in Nigeria (Alegbejo *et al*., 2003). It is an erect, flowering annual plant which grows 50 to 250 cm tall or more, as determined by the soil or environmental conditions and varieties (Sharma, 2005). Sesame is usually propagated by seeds and matured in 70 - 150 days after sowing, depending on the varieties (Indu and Savithri, 2003).
Fertilizer application among sesame growers in Nigeria (particularly in the north central part), has not been a common practice because it is considered as a minor crop and can do well even on poor soil (Haruna and Usman, 2008). In Nasarawa State, sesame is grown mainly as a sole crop. Farmers have no definite fertilizer recommendations for the production of sesame as a sole crop. The crop is grown in a mixture with sorghum or millet (RMRDC Survey, 2004).
Fertilizers are not always applied to sesame in major growing areas of Nigeria. The crop benefits only from the fertilizer applied to other crops grown earlier in the year. Unfortunately, growth and yield of the crop are generally low compared with the growth and yield obtained when fertilizer is applied. Reports of nutrition studies carried out in Nigeria and elsewhere have shown significant increase in growth and yield of the crop (Haruna and Abimiku, 2012). Low fertilizer use has been identified as a major challenge that must be overcome in order to increase Nigeria's agricultural productivity. However, there are several factors that contribute to low fertilizer use that are not addressed by direct price subsidies. First, the extension service system generally plays a critical role in driving demand for fertilizer through its transmission of information about fertilizer

technology to farmers. In Nigeria, the extension service is also instrumental in providing farmers access to fertilizer. Based on interviews with extension agents, Banful, (2010) found that the primary constraint to fertilizer use in Nigeria is the physical absence of the product at the time that it is needed, rather than problems of affordability or farmers' lack of knowledge about its importance. Therefore, there is an immediate need to conduct a study on the analysis of fertilizer application among sesame farmers in Nasarawa State.

Methodology

The study was carried out in Awe local government Area of Nasarawa State. The average rainfall is between 1000-1400mm with a high daily temperature range between 28^0C-31^0C which is favorable for agricultural production (NIMET, Station, 2014). The Area has a population of about 112,574 people inhabitants with Jukun (from Kwararafa Kingdom), people who constitute 95% of the ethnic groups in the area, while other minority tribes are Hausa, Tiv and Fulani (NPC, 2006). The local government share boundary with Taraba State and Benue State. It has an estimated land area of about 2521km^2, the major crop grown in commercial quantities are Rice, Sesame, Cassava, Groundnut and Millet (NADP, 2014).

Method of Data Collection and Analysis

Primary data were collected with the aid of a questionnaire. A simple random sampling technique was used for the study. Five villages namely Kekura, Tunga, Kanje, Baure and Mahanga were randomly selected for the study area. Sixteen farmers were randomly selected from each village making a total of 80 farmers that were used for the Study. Data were analyzed using simple descriptive statistics and regression analysis.

Regression model

$\text{Log}Y = \beta_0 + \beta_1\text{Log}_{(}X_{1)} + \beta_2\text{Log}_{(}X_2) + \beta_3\text{Log}_g(X_3) + \beta_4\text{Log}_{(}X_{4)} + \beta_5\text{Log}_{(}X_{5)\ldots} + e$

Where Y = Yield of sesame (kg)

X_1 = Labour (Man day)

X_2= Seed used (Kg/ha)

X_3 = Fertilizer (kg)

X_4 = Farm size (ha)

X_5= Agro chemicals used (liters)

β_0 = Constant term

β_1–β_5 = regression coefficient

e = error term

Results and Discussion

Socio-economic Characteristics of Sesame Farmers

The socio-economic characteristics of the respondents are presented in Table 1. The result showed that 53.2% of the respondents were between the age of 22-31years while 30.1% were between the age of 32-41years. The majority (71.4%) of the farmers were males while 28.6% were females. This implies that men engage more in sesame production than women in the study area. The result revealed that 93.7% of the respondents were married while 6.3% are single. The result further revealed that 46.7% of the respondents had primary education, 12.0% had secondary education, 3.1% had tertiary education, and 38.2% had no formal education. This indicates that majority 62.8% can read and write. The implication of the level of education of farmers is that it increases farmers' awareness on modern agricultural technologies and also the level of adoption of such technologies.

The result also showed that 20.6% had household size of 10-14 persons, 49.2% had household size of 15-19 persons, and 28.6% had household size of 20-24 persons. The implication of household size is that high household size discourages the use of hired labour in production. The result further showed that 80.1% of the respondents acquired their land through inheritance, 14.3% purchased the land, and 5.6% rented the land. Land holding through inheritance is common among rural farmers probably as a result of the social structure of the rural people.

Majority 60.1% of the respondents had farm size between 1 and 10ha, while only 20.5% had farm size greater than 10ha. The result further show than 6.3% of the respondents between 1-10 years had farming experience, and 41.3% had between 11-20 years, farming experience and 52.4% had between 21-30 years of farming experience. Farmers with much experience have some managerial skills that contribute to the overall productivity. In addition 65.5% of the respondent cultivate sesame as a sole crop while, 34.5% cultivate it as a mixed crop.

Table 1: Socio-economic characteristics of sesame farmers

Socio-economic characteristics variable	Frequency	Percentage (%)
Age (years)		
22-31	52	53.2
32-41	20	30.1
42-51	8	16.7
Total	**80**	**100**
Gender/sex		
Male	55	71.4
Female	25	28.6
Total	**80**	**100**
Marital Status		
Single	10	6.3
Married	70	93.7
Total	**80**	**100**
Education status		
Non formal education	24	38.2
Primary education	39	46.7
Secondary education	10	12.0
Tertiary education	7	3.1
Total	**80**	**100**
Household size		
10-14	15	20.6
15-19	45	46.2
20-24	20	28.6
Total	**80**	**100**
Method of land acquisition		
Inheritance	54	80.1
Purchase	18	15.3
Rent	8	5.6
Total	**80**	**100**
Farm size(ha)		
1-10	15	60.1
11-20	50	20.5
21-30	15	19.4
Total	**80**	**100**
Farmer experience(yrs)		
1-10	8	6.3
11-20	19	41.3
21-30	53	52.4
Total	**80**	**100**
Cropping pattern		
Sole cropping	60	65.5
Mixed cropping	20	34.5
Total	**80**	**100**

Source: Field Survey, 2015

Factors influencing inorganic fertilizer use by farmers for sesame production

The factors influencing inorganic fertilizer decision by the respondents were described in Table 2. The result showed that 37.5% of the respondents indicated that their reason for applying inorganic fertilizer to sesame was to obtain higher yield. Furthermore, 12.5% of the respondents indicated that they applied inorganic fertilizer because soil fertility was poor. Fifteen per cent indicated that they applied inorganic fertilizer based on advice by extension agents, while 2.5% indicated that fellow farmers advised them to apply fertilizer.

Meanwhile, 12.50% of the respondents reported high cost of inorganic fertilizer as the reason for not applying the fertilizer. From the result obtained the major reasons for farmers to apply inorganic fertilizer to sesame was because they wanted to obtain high yield while unavailability and high cost of inorganic fertilizer featured as the main reason for not applying the fertilizer.

Table 2: Factors influencing inorganic fertilizer use by farmers in sesame production

Reason for applying fertilizer to sesame	**Frequency**	**Percentage**
To obtain high yield/ effectiveness of fertilizer	30	37.50
Because of poor soil fertilizer	10	12.50
Based on advised by extension agents	12	15.00
Based on advice from other farmers	02	02.50
Reason for not applying fertilizer to sesame		
High cost of fertilizer	10	12.50
High soil fertility	05	06.25
Unavailability of fertilizer	07	08.75
Availability of organic manure	04	05.00
Total	**80**	**100**

Sources: Field Survey, 2015

Estimation of input and output relationship in sesame production

The result revealed that the f-value (2.436) was significant at 1%. The R^2 value of 0.723 implies that 72.3% of the variation in output of sesame production was explained by the inputs. Two of the explanatory variables, labour (mandays/ha) and farm size (ha) were both significant at 1% while the remaining explanatory variables, seed (kg/ha), fertilizer (kg/ha) and chemical (litre/ha) were significant at 5%. The positive value of the coefficients implies that the explanatory variables had positive influence on the dependent variable. The result indicated that as the variable inputs are increased the output will also increase.

Table 3: Estimates of the input and output relationship in sesame production

	Unstandardized Coefficients		**Standardized Coefficients**		
	B	**Std. Error**	**Beta**	**T**	**Sig.**
Constant	-12982.985	7904.469	0.000	-1.642Ns	0.104
Labour (Man-day)	0.570	0.136	0.194	4.180***	0.000
Seed used (kg/ha)	16.119	5.574	0.261	2.892**	0.005
Fertilizer (kg)	0.614	0.256	0.179	2.399**	0.019
Farm size (ha)	8211.219	2131.077	0.194	3.853***	0.000
Agrochemical used (Lit)	2.787	0.959	0.258	2.907**	0.005

Note: R = 0.781; R square = 0.723; Adjusted R square = 0.723; F-value =2.436 ;*** = Significant at 1%; ** = Significant at 5%, Ns = Not significant

Information sources on inorganic fertilizer application for sesame production Information source of inorganic fertilizer to sesame production is presented in Table 4 below. The result showed that about 51.5% of the sesame farmers obtain fertilizer application information from Radio programs, while 25.5% of the respondents obtain their information from extension agents. This shows that the major source of information to the farmers in the study area is by Radio.

Table 4: Information sources on inorganic fertilizer application for sesame production

Information sources	**Frequency**	**Percentage**
Radio	45	51.5
Extension agents	20	25.5
Other Farmers	10	13.5
NGOs	5	9.5
TOTAL	**80**	**100**

Sources: Field Survey, 2015

Conclusion

The study revealed that majority of the respondents used radio as their source of information on the use of inorganic fertilizer. Their decision on inorganic fertilizer used is to obtain higher yield due to poor in soil fertility. Despite the benefit of fertilizer to the productivity, some farmers still do not use fertilizer as found in this study. It can be concluded that high cost of fertilizer hinder farmers from using fertilizer.

Extension agents should create more awareness in the study area through established of small plot Adaptive technique (SPAT) demonstrating on sesame response to inorganic fertilizer. The E-wallet scheme should be employed by the state and local government to ensure that fertilizer gets to sesame farmers in the state. The complementary application to organic and inorganic fertilizer for sesame production should be perfected in terms of application rate for sesame production in the state. Government should improve on the use of radio medium for disseminating fertilizer application information to the farmers.

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Food Price Volatility and Food security in Nigeria: Current Issues and Possible Measures

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Abstract
The prices of food commodities globally have been characterized by increased volatility in recent years, generating a growing concern with regards to food security especially in developing countries. This paper focuses on food price volatility as it relates to food security in Nigeria and also discusses some policies and strategic measures to address price volatility in the food market. It is shown that volatility in food prices is caused by both demand and supply-side factors and that these factors are expected to persist such that high and volatile food prices will continue. Suggested possible measures for reducing food price volatility include the building of stock reserves, addressing climate change issues, increasing agricultural investments, and provision of social protection.
Keywords: Price volatility, Food security, Food deficit, Net importer

Introduction
Historically, agricultural product markets have been characterized by price volatility and recent market events have heightened the feeling that agricultural commodity price volatility will continue to increase in the future. Beginning from September 2006, world agricultural markets witnessed considerable fluctuations with prices rising to an unprecedented level by early 2008. These sharp upswings were most noticeable in maize, rice, wheat and dairy products. However, by mid-2008 through 2009, food prices declined sharply and rose again in 2010 and by 2011 prices rose to the peak of the price increase in 2008. Again, since 2012 food prices started falling in the global agricultural markets and then rose again markedly by 2017 (Figure 1). Thus, within the past ten years many agricultural commodity prices fluctuated sharply, rising and falling at different periods. Such rather exceptional volatility in world food prices generates considerable uncertainty for all market participants, makes both short and longer term planning very difficult, and poses serious threats to the food security of vulnerable people especially in developing countries (Saris, 2013).

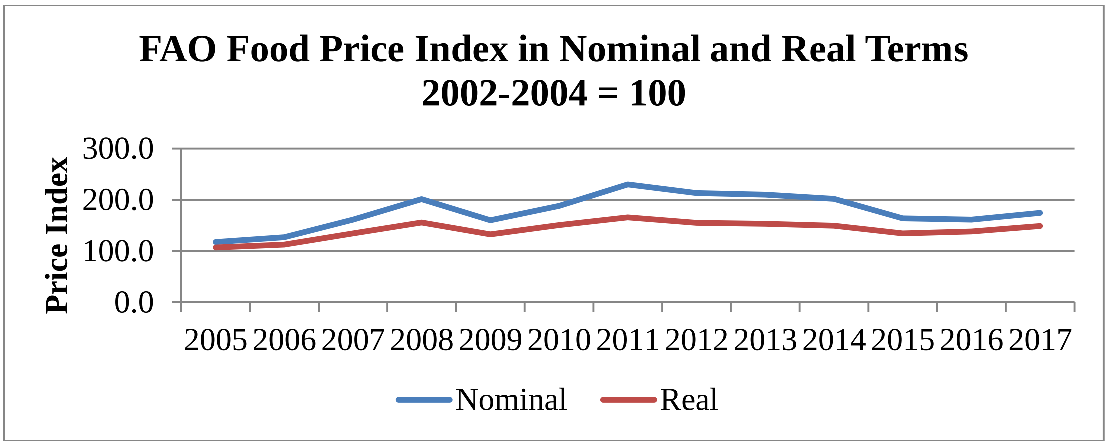

Figure 1: Food Price Index
Source: FAOSTAT, 2018

Previous research has identified and strongly debated on a variety of structural and temporary factors that are responsible for such unpredictability in food prices (Mitchell, 2008; Abbott et al., 2009; Gilbert & Morgan, 2010; Harrigan, 2014; Woertz et al., 2014; Kalkuhl et al., 2016). On the demand side, volatile food prices are caused by population growth, shifts in diets in emerging markets, stronger interlinkages between the food, feed, energy and financial markets. Supply-side factors include harvest shortfalls, declines in productivity, climate change and ecological constraints, high cost of inputs such as fuels and fertilizers, low inventory levels, and global catastrophes. As noted by Harrigan (2014), the causes behind the global food crisis are expected to persist such that high and volatile food prices will continue.

Food price volatility generates significant concerns that border on food security and has a significant impact on the welfare of poor individuals or countries who are net buyers of food. The impact of price volatility extends to farmers, market actors, consumers, and governments in many countries. The share of food consumption in total household consumption is substantially high for many developing countries and as such food price volatility can bring about significant hardships for consumers and even trigger riots (Gilbert & Morgan, 2010; Arezki et al., 2016). Existing evidence (Table 1) shows that food insecurity is a pressing issue in many developing countries and Africa is the continent most subject to food insecurity in the world, thus making food price stabilization and food security a major objective of governments in these countries (Gouel et al., 2016; McCorriston & MacLaren, 2016).

Based on the Global Food Security Index (GFSI) which considers the core issues of food affordability, availability, quality and safety across 113 countries in 2017, Nigeria is ranked 92 with a score of 38.4. With this pathetic situation, it becomes very crucial to understand the food security situation in Nigeria with a view to providing possible policy measures that could help address market instability, reduce hunger and enhance food security. This then is the major motivation of this paper.

Table 1: Food Insecurity in Selected African Countries

Country	Score/100	Rank
Benin	39.6	90
Mali	39.4	91
Nigeria	38.4	92
Togo	37.2	93
Tanzania	35.4	95
Sudan	34.8	96
Guinea	34.0	97
Mozambique	33.7	98
Ethiopia	33.3	99
Angola	33.2	101
Burkina Faso	33.1	102
Zambia	32.4	104
Malawi	31.3	105
Niger	29.5	106
Sierra Leone	28.7	109
Chad	28.3	110
Madagascar	27.2	111
Congo (Dem. Rep.)	25.5	112
Burundi	25.1	113

Source: Economist Intelligence Unit, Global Food Security Index 2017
Note: Score 0-100, 100= best environment

The State of Food Security in Nigeria

The FAO crop prospects and food situation released in June 2018 reveals that Nigeria is among the 39 countries in need of external assistance for food (FAO, 2018a). Food insecurity has continued to be driven by persisting conflicts and weather shocks which have adversely impacted access and availability of food stuff. Based on a three-year average (2014-2016), the number of undernourished in Nigeria is about 14.3 million with a 7.9% prevalence of undernourishment while the depth of food deficit is 48kcal per capita per day (FAO, 2017).

As one of the potentially food insecure countries in the world, Nigeria is a net importer of food despite its enormous agricultural potential. Nigeria has a large food deficit and is a net cereal importer with cereal import projected to reach 7.8 million tonnes in 2018. Furthermore, the country is the largest importer of rice in Africa with an average of about 2.6 million tonnes of rice import annually (FAO, 2018b). Its food imports as a share of total imports in 2017 is 16.3%, representing about double the world average of 8.3% with the food import bill in 2016 standing at 1.1 trillion naira (National Bureau of Statistics (NBS), 2018).

The huge food gap in Nigeria, revealed by the large food imports is due to the inability of the country to realize an increase in agricultural production to meet the growing food demand. The high rate of population growth is partly to blame for this situation as the average annual growth rate of population in the last decade is about 2.6%. Nigeria is currently the seventh most populous country globally with a more than 6.5% average annual growth rate of the urban population. Other causes of the food gap include decades of underinvestment in agriculture, local conflicts and climate change which have led to the displacement of a significant segment of the population and an increase in poverty and diseases. With poverty levels exceeding 50% of the population, most people in Nigeria are vulnerable to food price fluctuations.

Measures for Reducing Food Price Volatility

Addressing food price volatility is very crucial given the fact that price instability has adverse impact on the poor and poses a threat to the attainment of food security. The adoption of a broad approach that encompasses storage policies, marketing, stocks, trade, climate change, conflict management, and social protection to target food price stabilization can help in managing excessive food price volatility in Nigeria. Collective storage and marketing strategies can be used by producers and farmers organizations to prevent over-commercialization which arises due to lack of storage capacity and household liquidity constraints during harvest season. The use of national food reserves (based on collaboration between the public and private sectors) can also help to overcome temporary disruptions in food supply considering that low grain stock levels can potentially exacerbate food price instability. Thus, there is need to increase the capacity to stock food in Nigeria in case of price volatility. Because food price volatility and food security are strongly linked to climate change, government policies should be designed to address greenhouse gas emissions and facilitate increased productivity boosting investments in climate change adaptation and resilience to shocks. In addition, safety nets also play a critical role in relieving the effects of short-term food price instability on food insecurity arising from local conflicts. In this light, social protection and protective measures such as cash transfers and employment programmes can be used to address short term risks associated with food price fluctuations.

Conclusion

Food price volatility is a major concern in Nigeria, affecting the most vulnerable in the society and threatening the food security target of the country. High rate of population growth, low investments in the agricultural sector, conflicts and climate change have contributed in creating large food deficits in Nigeria, leading to agricultural market volatility. Dealing with food price volatility requires a combination of different approaches including the building of stock reserves, addressing climate change issues, increasing agricultural investments, and provision of social protection.

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Analysis of Household Demand for Beef in Adamawa State, Nigeria

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Abstract
This study analysed the household demand for beef in Adamawa State using AIDS model. The AIDS model result revealed that five coefficients of the variables were statistically significant. These include the age of the household head (5%), marital status of the household head (5%), occupation of the household head (1%), educational level of the household head (10%) and the child dependency ratio (10%). The coefficients of the household head; age, occupation, secondary education and the child dependence ratio were negative. While the coefficients of marital status showed a positive coefficient. The expenditure elasticities of beef, poultry and fish revealed that all the coefficients were positive and statistically significant at 1% level. The study recommends reduction on income taxation for low income salary earners, investment in livestock production, provision of credit facilities to livestock farmers and improvement on educational attainment.
Keywords: Analysis, Household, Demand, Beef and AIDS Model

Introduction
Beef is the term used to designate meat from different types of cattle; it is usually applied to meat of cattle over one year old. Beef contains 15-20 percent protein of outstanding nutritive value. It is also an excellent source of some of the vitamin B complex and a good source of iron and phosphorus; it also contains sodium and potassium. The vitamins and minerals are found in the lean portion of the meat. Meat (beef) is rich in most of the nutrient required by man. This is to be expected since the tissue and body fluid of man are very similar to those of animals. Meat (beef) is rich in protein and contains all the essential amino acids, which are very good for the maintenance and growth of human tissue. It is also rich in minerals and vitamins. Moreover, phosphorus, copper and iron are present in significant amount in meat (Khader, 2001 and Manay and Shadakshoraswamy, 2001).

World demand for meat has risen sharply during the last few decades. The key reason for these increases in meat demand are increasing population, improving technology and increasing incomes. However, despite the overall improvement in technologies and per capita income consumption of meat has lagged especially in the less-developed countries of the world because protein is the most costly food item (Goliath, 2005). The increase in meat consumption is a universal desire to diversify diet and eat meat, dairy products and fish when income per capital increases. Today, the increasing human population in the face of inelastic production strategies appears to have widened the demand-supply gap and accentuates society's demand of meat product (Igwe and Onyekwere, 2007).

The global beef consumption is expected to rise gradually by about 1.6% per year in average in the Food and Agricultural Policy Research Institute (FAPRI) projections in relation to income growth, notably in the emerging economies. In many developed countries, the per capita consumption of beef is expected to stagnate or to fall, since consumers continue to substitute beef meat with pork and poultry meat. The declining beef meat consumption is influenced mainly by the decreasing purchasing power and the occurrence of the Bovine Spongiform Encephalopathy (BSE) disease. The elasticity estimation result revealed that the beef meat is price and income inelastic (Hupkova, Bielik and Turcekova, 2009).

Bastian (2008) reported that, consumer concerns with beef were related to cholesterol, calorie content, artificial ingredient, convenience characteristics (Microwaveable and storage), how it is displayed in the store, and price (too expensive). Each of these factors exhibited a statistically significant negative effect on the quality perception of beef compared to other meats. Wohlgenant (1985) attributed the decline in beef consumption to increased nutritional consciousness of consumers and changes in relative prices as well as real income. However, the change in elasticity relationship between beef and fish from substitutability to complementarity might reflect a desire on the point of consumers, in response to health concerns about red meat, to expand their diets to include fish. Moreover, the decrease in the consumer demand for beef is due to age related sicknesses such as heart disease and arthritis (Kudi *et al.,* 2008).

Beside, the decline in consumer demand for beef as compared to other sources of animal protein such as pork, poultry, fish and sea food are due to many factors. The numerous factors that jointly influence beef demand over time can be broadly categorized as (i) relative prices (or quantities), (ii) consumer incomes, (iii) health/nutrition concerns, (iv) food safety concerns, and (v) consumer preferences for meat product attributes. Beside aging population is one of the factors that are causing changes in meat consumption. Older people of nearly 50 years and above tend to consume more poultry and less beef (Schroeder and Mark*,* 2000).

Moreover, animal protein consumption in developing nations is low because animal products are more expensive than other food and their consumption is closely related to the level of income, which are generally low (Murtala *et al.,*2005). Animal protein consumption is closely related to the level of income because animal products are more expensive than plant protein and other foods. As the level of real income improves, people tend to substitute high quality foods, notably animal products for carbohydrates in their diet plan. Per capita animal product consumption is a good indicator of the gross domestic product and standard of living of a country (Amoo, 2005).

Methodology

The research was carried out in Adamawa State of Nigeria. Multi-stage random and systematic sampling techniques were employed for the selection of one hundred and ninety six (196) households used for the study. The analytical tool used was AIDS model. The AIDS model suggested by Deaton and Muellbauer (1980) has enjoyed great popularity in applied demand analysis starting from the Gorman polar cost (expenditure) function. The AIDS demand functions in expenditure (budget) share is given by:-

$$\omega_i = \alpha_i + \sum \gamma_{ij} \ln \mathrm{P_j} + \beta_\mathrm{i} \ln\left(\frac{x}{p}\right) + \mathrm{U_i} \quad (1)$$

Where:-

wi = the budget share for good i

α_i = The constant Coefficient in ith share equation

γ_{ij} = The slope coefficient associated with the jth good in the ith share equation (Price Coefficient)

P = the price of commodity (Price Index)

β_i = Expenditure Coefficient

U_i = The disturbance/Error term

The AIDS model needs to satisfy the adding up, homogeneity and symmetry conditions.

The adding up restriction is:-

$$\sum\alpha_j = 1, \sum\gamma_{ij} = 0, \sum\beta_i = 0 \text{ (adding up)} \quad (2)$$

Some socio-economic/demographic variables other than price and income were incorporated into the model by allowing the intercept in equation (1) to be a function of demographic variables as:-

$$\alpha_i = p_{io} + \sum_{j=i}^{S} P_{ij} d_j \quad (3)$$

Where dj = jth demographic variables of which there are S.

The new model, including the demographic variables and an error term u_i is then defined as: -

$$\omega_i = p_{io} + \sum_{j=1} p_{ij} d_j + \sum_j \gamma_{ij} p_j + \beta_i \text{In}\left(\frac{\text{x}}{\text{p}}\right) + u_i \quad (4)$$

The adding up requirement under the specification with the demographic variable now requires that:

$$\sum_j p_{io} = 1, \ \sum_i p_{ij} = 0 \ (j = 1, \dots \dots \dots, S) \quad (5)$$

Elasticity was also incorporated in the model as follows:-
The price elasticity in the AIDS model is given by:-

$$\epsilon_{ij} = -\delta_{ij} + \frac{\gamma_{ij} - \beta_i(\alpha_i + \sum \gamma_{ij} \ln p_i)}{\omega_i} \quad (6)$$

Note: In practice the term given by ($\alpha_j + \sum \gamma_{ij} \ln p_i$) may sometimes be replaced by the equivalent $\left(\text{wj} - \beta\text{jln}\left(\frac{\text{y}}{\text{p}}\right)\right)$in elasticity expressions.
Expenditure (income) elasticity is given by:-

$$\epsilon_{iy} = \frac{\beta_i}{\omega_i} + 1 \quad (7)$$

Results and Discussion

The analysis of the determinants of household demand for beef obtained from the Almost Ideal Demand System (AIDS) model is presented in Table 1. The result revealed that five explanatory variables used in the model, namely; age, marital status; main occupation, secondary education and child dependency ratio significantly affect households' demand for beef. The result revealed that the coefficients of age of household head, main occupation, secondary education and child dependency ratio were negatively related to the budget share on beef, meaning that an increase in these variables would decrease budget share allocated to beef.
However, the coefficient of marital status was positively related to the budget share on beef, implying that households that are married increase their budget share on beef. The statistical significance of age of household heads at 5% level indicates that as the age of household head increases, the budget share (expenditure) on beef decreases. This may be attributed to the linkage between beef consumption and age related sicknesses such as heart disease and arthritis as discovered by (Kudi *et al.,* 2008). Hence, households that have attained certain age decrease the consumption of beef because of the associated health hazards. This is in line with Schroeder and Mark (2000) who found a link between cholesterol and heart disease.

Table 1: AIDS Parameter Estimates for Beef in Adamawa State

Parameter	Beef
Constant	0.558**
	(2.38)
Price of beef	-0.012
	(-0.023)
Price of poultry	0.023
	(0.67)
Price of fish	-0.011
	(-0.24)
Expenditure	0.032
	(1.04)
Gender	-0.099
	(-1.24)
Age	-0.004**
	(-2.11)
Marital status	0.125**
	(2.35)
Main occupation	-0.087**
	(-2.29)
Household size	0.012
	(1.11)
Primary education	-0.067
	(-1.42)
Secondary education	-0.092*
	(-1.89)
Tertiary education	-0.104
	(-1.54)
Child dependency ratio	-0.184**
	(-1.95)
Adult dependency ratio	0.064
	(0.025)

Source: Computed from Result of AIDS Model
Figures in parentheses denote Z-values. *** denotes significance at 1% level
** denotes significance at 5% level * denote significance at 10% level

The coefficient of main occupation is statistically significant at 5% level and negatively related to expenditure on beef implying that respondents whose main occupation is farming tend to decrease their expenditure on beef. This may be attributed to their low income status where respondents rely more on cheaper protein sources instead of spending the meager resources on beef. This is in line with Hupkova *et al* (2009) who opined that, the declining beef meat consumption is due to the decreasing purchasing power of the consumer.

The statistical significance of secondary education at 10% level indicates that household heads that has attained secondary level of education decreases their budget share (expenditure) on beef. At that level of education, respondents are not expected to have good Jobs that can earn them better income so as to increase their demand for beef. This might be the reason why majority of them are farmers. The coefficient of child dependency ratio is statistically significant at 5% level and negatively related to expenditure on beef implying that respondents with high child dependency ratio tend to decrease their expenditure on beef. This is a deviation from *apriori* expectation where high child dependency ratio is expected to increase demand for beef, although low income could result to this situation. This is in confirmation with Murtala *et al.* (2005) findings that animal protein consumption in developing nations is low because animal products are more expensive than other food and their consumption is closely related to the level of income, which are generally low. The statistical significance of marital status at 5% level indicates that household heads that are married tend to increase their budget share (expenditure) on beef. Household size tends to be higher among households that are married than unmarried households, and this tends to increase the expenditure on beef.

Table 2 shows the expenditure elasticities of beef, poultry and fish. It reveals that all the coefficients were positive and statistically significant at 1% level, implying that all of them are normal goods, whose consumption will increase with increase in income. Of the normal goods, beef and poultry have fallen under luxury goods by virtue of their elasticity coefficients (>1). Thus, a 1% increase in household expenditure (income) will increase the demand of beef by 1.07% and that of poultry by 1.56%. However, the household demand for fish is inelastic (0 < e < 1) and can be considered as a necessity. Thus, a 1% increase in household expenditure (income) will increase the demand of fish by 0.75%.

Table 2: Household Expenditure Elasticities of Beef, Poultry and Fish in Adamawa State

Parameters	Elasticity coefficient	Elasticity
Beef	1.065*** (17.01)	Elastic
Poultry	1.563*** (9.07)	Elastic
Fish	0.753*** (10.51)	Inelastic

Source: Computed from AIDS Model result.
*** indicates significant at 1% level.
Z-values are in parentheses

Conclusion and Recommendations

This study analysed the consumer demand for beef in Adamawa State using AIDS model. The results of this study will add to the existing literature on consumers demand and expenditure using AIDS model. The estimated results may be useful to researchers working on the related topics in future. The AIDS model result revealed that five coefficients of the variables were statistically significant. These include the age of the household head (5%), marital status of the household head (5%), occupation of the household head (1%), educational level of the household head (10%) and the child dependency ratio (10%). The coefficients of the household head; age, occupation, secondary education and the child dependence ratio were negative, meaning that the variables were inversely related to the budget share allocated to beef. While the coefficients of marital status showed a positive coefficient indicating a direct relationship to the budget share. It reveals that all the coefficients were positive and statistically significant at 1% level, implying that all of them are normal goods, whose consumption will increase with increase in income.
Based on the findings of the study, the following recommendations are hereby proffered:
Government should reduce income taxation for low income salary earners as well as subsidizing farmer's farm inputs for increase production, so as to raise their disposable income which will enhance households demand for beef as well as other animal protein sources for healthy living.
Individuals, government and non-governmental organization should invest in livestock production in order to make beef and other animal protein products not only available in large quantity for consumption but also affordable since price is the major determining factor for consumer demand.

Credit facilities through banks and other financial institutions should be made available to farmers and with simplified procedures in order to boost livestock production in the study area and the nation as a whole, thereby, reduced the prices and enhance consumption of beef other animal protein products.

Since majority of the respondents were secondary school leavers. That the statistical significance of secondary education at 10% level indicates that household heads that has attained secondary level of education decreases their budget share (expenditure) on beef. There is need for them to improve on their educational attainment to attract good jobs and earn better income to enhance high demand for beef and other animal protein sources.

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Transactions Cost of Market Participation for Cassava in Nigeria: Implications for Agricultural Trade

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Abstract
In Nigeria, strong demand and the fact that most of the nation's more than 180 million people are in the hands of smallholders provides a tremendous opportunity for cassava farmers to participate in the cassava market and increase rural incomes. Unfortunately, recent output has not kept pace with increasing demand, suggesting that barriers prevent rural farmers from participating in the market. Increased transaction costs deter entry of small farmers into the market. This review looks at interventions aimed at reducing transaction costs to encourage increased farmer participation in competitive markets. The study raises policy issues which, when attended to, might reduce fixed and proportional transaction costs, particularly by enhancing access to credit, extension and providing market outlets and bulking centers for farming households and rural infrastructure, especially good road networks. Some constraints require direct policy measures dealing with education, and then there are those that require stable policy environment for small-scale traders to promote significant farmer response. The conceptual and empirical evidence suggests that interventions aimed at facilitating rural smallholder cooperatives, by reducing transaction costs are central to stimulating market participation.
Keywords: Fixed Costs, Proportional Transactions Costs, and Cassava

Introduction
Two broad categories of transaction costs, proportional and fixed transaction costs, have been identified in literature (Key *et al*., 2000). Others have distinguished transaction costs between tangible (transportation costs, communication costs, legal costs, etc.) and intangible (uncertainty, moral hazard, etc.) costs (Holloway *et al*., 2000 and Birthal *et al*., 2005). Key *et al*., (2000) introduced a distinction between fixed or lump sum transaction costs, on the one hand, and variable, proportional or per-unit transaction costs on the other hand. They show that both fixed and variable transaction costs impact on market participation whereas supply decisions (amount sold), conditional on market participation, only depend on proportional transaction costs.

Proportional transaction costs change according to how much a household sells or buys (e.g., per unit transportation costs and price premiums deriving from bargaining capacity). Fixed transactions costs are independent of the quantities sold or bought (Vakis *et al*, 2003). It is the bundle of transaction costs that farmers face that determines market participation. Interactions between the unique features of food system participation and other household- and location-specific characteristics can further exacerbate transaction costs. Farmers will not enter markets when the value of participating is outweighed by the costs of undertaking the transaction (Sadoulet and *de* Janvry 1995).

Cassava is a staple food crop in South-Eastern Nigeria and it contributes about 15% of the daily dietary energy intake of most Nigerians and supplies about 70% of the total calories intake of about 60 million people in Nigeria (Ezulike *et al*., 2006). Nigeria is the world's largest producer of cassava; with about 54 million metric tonnes and average yield of 14.03tonne/ha (FAOSTAT, 2012).

Fresh cassava roots, with about 70% water content, are bulky and therefore expensive to transport especially over long distances. The roots are also perishable, and begin to deteriorate soon after harvest. These features are expected to have profound bearing on the trade network for the roots. For instance, the bulky nature of the roots makes the market for fresh roots more localized around the producing areas than the market for processed cassava products. Also the perishability factor makes the marketing process considerably shorter for fresh roots than other cassava products (Ezedinma *et al*., 2007).

Promoting market-orientation among agricultural producers, more so the smallholder farmers, in developing countries is pivotal for development of effective agribusiness value chains that could supply adequate food. This will involve improving the production and marketing processes as well as capacity for income generation among resource-poor farmers (Otieno *et al.,* 2009).

One variable that can be used to access the trend in Cassava commercialization at the rural farm level is the proportion of cassava output that farmers sell after harvest from their fields. Cassava roots can either be sold (in roots or processed form) or consumed at home in the South-South and South-Eastern Nigeria (Ezedinmma *et al*., 2007). The proportion sold suggests a higher degree of commercialization of the commodity. The Collaborative study on Cassava in Africa (COSCA) had used these variables along with others as indicators of cassava commercialization to show that on the average, Nigerian farmers were willing to sell about 45% of their cassava output 15 years ago (Nweke, 1994).

Transaction Costs Economics is especially relevant for agricultural market analysis in developing countries because many of the institutions, or formal rules of behaviour, that are taken for granted in developed countries which facilitate market exchange are absent in low-income countries. The frequent occurrence of market failure and incomplete markets (i.e. caused by higher transaction costs and information asymmetries) in developing countries requires an institutional analysis. This could help to determine what types of institutions are needed (either formal or informal) to improve the economic performance in developing countries (Makhura, *et al.,* 2001).

Methodology

Review of literature for transactions cost and mitigating factors were highlighted. The country Nigeria lies between the geographic co-ordinates, latitudes $4^01'$ $13^09'$N and longitudes $20^02'$ and $14^030'$E. The nation borders the Gulf of Guinea on the south, Cameroon and Chad on the east, Niger on the north and Benin on the west. With a total of 923, 768 square Kilometers of space, the country has an estimated population of 140, 003, 542 inhabitants and a population growth of 2.5% annually (NPC, 2006). The nation Nigeria has six Geo-political Zones viz. North-East, North-West, North-Central, South-East, South-West and South-South.

Results and Discussion

Farmer's decision to participate in the market at any time is influenced by the combined (simultaneous) effects of fixed and proportional transaction costs factors.

Transaction Cost Determinants

Information and search costs related

Frequency of Extension contact: Agricultural extension services provided by the ADPs are the major source of agricultural information in the study area. Frequency of contact with extension workers will increase farmers' likelihood of participating in the market as a result of decreased fixed cost of participation.

Membership of Cooperative societies: Social networks are expected to reduce fixed costs of participation because members may be able to access information about price asymmetries and markets etc within the network.

Access to Communication facilities: Information is acquired through phones, internet, radio, television, extension guides and bulletins etc. It is important that this information be reliable, consistent and accurate. Thus, the right mix of information properties is needed for effectiveness in participation decisions.

Education: Exposure to education should increase a farmer's ability to obtain, process, and use information for market participation. Education thus is thought to increase the probability that a farmer will participate more in the market as a result of decrease in fixed costs associated with education.

Bargaining and Negotiation Costs related

Sex: It is expected that the relative role women play in 'effort' in terms of bargaining suggests that women participate more than their male counterparts in cassava marketing as a result of reduction in fixed costs emanating from bargaining power.

Age: Age is a latent characteristic in the participation decisions. Farmers who are younger may be expected to have more bargaining strength for better prices than their aged counterparts. Dialogue has to take pace between buyer and seller and this demands negotiating skill on both sides in order to arrive at the most advantageous 'deal'.

Native of Community: Natives of the community culturally have more credibility among their kinsmen and members of the community. This lowers the fixed cost of participation as a result of more bargaining power. Therefore they are expected to participate more in the market than their counterparts who are migrant farmers.

Farming experience: A farmer's experience can generate confidence. With more experience, a farmer can become more credible and vast in terms of prices, thereby leading to better bargains and reduction in fixed costs of participation.

Monitoring and Enforcement Costs related

Time to get paid in days: This fixed cost occurs ex ante since the transaction has already taken place. Default in payment as at when due/agreed extending the time of payment increases fixed costs of participation

Number of times asked for payment: Increase in the number of times asked for payment is expected to increase fixed cost of participation in the market making farmers opt out of markets.

Have trust in Buyer: This is expected to lead to a reduction in fixed cost leading to increased participation. Trust in buyer will reduce the length of monitoring.

Proportional Transaction Costs Related (PTCs)

Personal Means of Transportation: Farmers with means of transportation are expected to have lower proportional costs leading to increased market participation.

Distance from the farm to the market: Farmers' who travel long distances to the market experience high proportional transaction costs constraining them to buyer conditions selling in the farm because of the bulky nature of cassava as well as the road conditions.

Distance to the nearest town: Farmers' with long distances to the nearest town are constrained accessing information and markets in these towns as a result of huge PTCs associated with traveling.

Distance from the house to the Market: Farmers' with long distances from the house to the market may prefer to sell cassava at the farm gate as a result of huge proportional transaction costs associated with market participation.

Distance from the house to the farm: Farmers' with long distances from the house to the farm may be constrained to sell at the farm gate to mitigate the proportional transaction costs of traveling again from the farm to the market to sell.

Volume of Credit: Credit will lead to decreased proportional transaction costs leading to increased market participation. This is measured in naira

Crop transportation costs: Increase in crop transportation costs will lead to increase in proportional transportation costs. This will increase the cost of traveling to the market either from the farm or the house to make sales.

Household Size: Because larger households are more likely to provide the labor that might be required to move cassava to the market, a larger household size would be expected to increase market participation thereby leading to a decrease in proportional transaction costs.

Dependency ratio: Increase in dependency ratio is expected to lead to a decrease in market participation because the aged and the children may not be able to give any support in terms of labour reduce proportional transportation costs.

Marketing experience: Marketing experience is expected to reduce the proportional transaction costs of participation.

Farm income: Farm income is expected to reduce the proportional transaction costs of market participation.

Road conditions to the nearest town: If road conditions to the nearest town are good more farmers are expected to participate in the market because of reduction in proportional transaction costs.

Yield: Yield is expected lead to increased farm gate sales as a result of the bulky nature of cassava. This will lead to increased proportional transaction costs of market participation as a result of increased distances from the farm to the market and road conditions.

Non-farm income: Non-farm income is expected to lead to increased market participation as a result of decrease in proportional transaction costs.

Conclusion

Smallholder cassava is characterized by low levels of market participation. The results support previous studies that existence of transaction costs constrains households from selling. While transaction costs are difficult to measure, understanding the impact they have on behavior is crucial as it can inform policy design aimed at reducing them. This review shows how different types of transaction cost influence decisions and outcomes for farm-households in South-Eastern Nigeria. Collectively, these results demonstrate the importance of allowing for non-negligible fixed costs in market participation studies. When these costs are ignored but are non-negligible, a significant bias in participation and level of sales estimation appears to exist. Policies that reduce transaction costs through improved transportation, promotion of organizations for marketing, improving rural infrastructure (e.g., access roads), credit access, encouraging the younger marketers especially women to increase marketed output will lead decrease in transactions cost of marketing cassava

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Agricultural Policies and Economic Development in Contemporary Nigeria: A Thematic Approach

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Abstract
This paper reviewed the place of agriculture and agricultural policies in Nigeria's quest for economic development and growth. Agriculture long before and after independence was the base of our economy and held the forte until petroleum was discovered in commercial quantity. Agriculture has a high propensity for inclusive growth. It ensures food security, provides raw materials for industrial production and development. It is a panacea to the problem of a mono product economy and a shift from dependence on oil to a diversified economy. Being labour intensive, it has the capacity for massive job creation, thus reducing the present high unemployment rate in the country. Agriculture has the potential to raise GDP, reduce unemployment, accelerate industrialization, increase foreign exchange and arrest the rampaging poverty. Unfortunately, it has been ignored by successive governments in Nigeria. Empirical evidences have shown that agriculture for now is the cheapest and easiest way out from the present economic predicament of the Nigerian economy.
Key words: Agriculture, economic, development, food security, unemployment, poverty.

Introduction
Nigeria though battling with huge external debt has tried exploiting and exporting her natural resources for sustenance these years. However, contemporary international debt issues have become increasingly challenging in generating enough resources for sustenance without increased pressure on resources (monetary in particular) for the production of goods for local consumption and agricultural products for export. In order to meet its obligations in the face of the mounting economic challenges (especially foreign and local debts), economic policies and programs have been introduced. These include self-sufficiency in food and raw materials production, employment generation, increases in exports, rural development etc. these are reflected in the objectives of the structural adjustment program (SAP) of years gone by. Agriculture, many scholars believe, can be an easier and cheaper alternative among other options to getting out of debts and growing the economy.

Development of the Agriculture sector appears a most probable option and would imply sustained increases in production and productivity and improvements in the wellbeing of the farmers and the general populace who will experience higher per capita income. Agricultural development will not only include sustained increases in production and productivity but also lead to sustained social and economic improvement in rural communities. To achieve these goals through agriculture, there should be a systematic improvement in institutional, physical and social infrastructures (Tunji, undated blog).

Notably, the agriculture sector's performance from political independence has been declining steadily from a 75 per cent contribution to Nigeria's GDP in the 1960s to less than 50 per cent in 1990s. For 2nd quarter 2017, agriculture contributed 28.08 percent to nominal GDP and 24.44 percent in the 3rd quarter. The factor responsible for this is the exploration of oil and gas and the attendant boom in the 1970s. Other reasons for the decline are the poor funding in the budget and the poor implementation of agriculture-focused policies. Notwithstanding these, agriculture is believed to be the easiest routes to structural changes and economic diversification since the country is richly endowed and agricultural production and processing do not require complex technology and, there is the propensity for increased productivity from the adoption of appropriate technology for varieties of improvements and fiscal incentives (Ogunleye, 2017).

Olajide *et al*., (2012) argued that for development to take place especially economic development, a nation has to pass through some stages such as a traditional stage necessary for industrial take-off, the take off stage itself needed to drive the nation to maturity and finally a high mass consumption stage. Agriculture played crucial roles in stages one to three and the agricultural sector is very necessary for the industrial and economic springboard a country needs for development to take off. Agricultural activities normally are concentrated in the rural areas where the need for rural transformation, redistribution, poverty alleviation and socio-economic development is critical.

From contemporary realities, possessing natural resources like petroleum, natural gas and other forms of mineral resources does not automatically guarantee economic growth for a country. Many crude oil bearing economies witnessed significantly stagnated economic growth in the 1970s and 1980s. From Gylfason (2001) studies, natural resource–rich countries which includes Nigeria, struggle to attain long-term investments of more than 25% of Gross Domestic Product and, per capita income growth of more than 4 percent per annum on the average from 1970 to 1998. Many countries like Nigeria, Angola, Sudan, Congo etc are rich in natural resources such as crude oil, diamond, and other minerals; yet they have a very low per capita income (Amini, 2018). From empirical literature, the link between natural resources, human capital development and economic growth has been consistent among countries and, it has been observed that economic growth has an inverse variation with natural resource abundance, human capital development measured by educational inputs or participation; however economic growth varied directly with education (Akpan et al, 2014).

Table 1: Regression Results: Natural Resource Abundance vs Economic Growth and Human Capital Development

Dependent Variable	Constant	Natural Capital	Human Capital Accumulation	Investment	Per Capita Income	R^2
Economic Growth	30.55 (0.75)	-1.55 (-3.12)***	4.19 (0.72)	4.29 (1.1)	6.46 (2.71)**	0.71
Human Capital Accumulation	15.08 (6.32)***	-0.29 (-6.46)***			0.59 (1.43)	0.53

T-statistics are shown within parentheses. *** And ** indicates significance at the 1% and 5% levels respectively
Source: (Akpan *et al.,* 2014)

Empirically, the relationship of natural resource availability, human capital development and economic growth in Nigeria indicated an inverse relationship between natural resource availability and economic growth. This relationship is strong both statistically and through econometric evaluation; all pointing to a negative influence on growth and has a coefficient that is significant at 1% level of confidence. A one percent increase in earnings from natural resource exploitation (petroleum oil mineral) resulted in a retardation of economic growth by 1.55%. The result also shows that resource-human capital equation results pointed to the fact that natural resource availability also had an inverse relationship to human capital development in Nigeria implying that as the share of natural resource rises in national income, there is the likelihood for the government to pay more attention to her natural resource assets and neglecting other assets (Akpan *et al*., 2014). Amini (2018) also reported that all countries that had access to oil wealth or other natural resources displayed similar behaviour compared to their contemporaries without such advantages. This may be because the presence of these resources can crowd-out human and physical capital accumulation. Therefore the assertion should be carefully studied because of its implications on other sectors of the economy such as agriculture, education and development policy (Akpan *et al*., 2014).

The Impacts of Government Policies on our Agricultural Development Continuum

Olajide *et al.,* (2012) reported that agriculture is of great importance to a nation's development process and provides the ingredient for most of the world's great civilization in times past and recalled that the increase in agricultural productivity in ancient England paved the way for and initiated the industrial revolution. This kind of transition and progress through agriculture is only possible through good and sustainable policies.

Agricultural development therefore will need good and viable policies to remain supportive and sustainable in any economy. Policies should mainly target economic adjustments: the macroeconomic and structural adjustments. The former refers to policy changes aimed at reducing or eliminating disequilibrium in the economy and may involve changes and short-term remedies for immediate problems and influence demand in the economy. Agricultural policies should depend on a resource base that is both sustainable and productive. The challenge today will be how to increase productivity while at the same time enhancing the productive capacity of resource bases. Policy interventions by successive Governments in Nigeria targeted improvements in agricultural productivity. Yet, the country made very little progress. These policy interventions have aimed largely at enhancing productivity and jobs creation specifically (Ogunleye, 2017) without targeting a sustainable resource base.

Government policies on agricultural development may need to shift from the contemporary emphasis on low-rent resources like artisanal activities and even crude exploration to alternative income sources which agriculture offers. Countries with low rents in their natural resources, some scholars have advised, should develop alternative economic sources with high potentials for wealth creation that can aid the provision of public goods and incentives for investments in both economic and social infrastructure and agriculture fits into the picture. These alternative activities will induce the development of the manufacturing sector that may boost government revenue (Akpan *et al.,* 2014). In this concept, changes and redirection of government investment will be a single important policy instruments that many developing countries can use to promote inclusive growth in agriculture through equitable resource distribution (Ebere *et al*, 2014).

Government organs responsible for instituting policy interventions to promote agriculture for inclusive growth must sit up if agriculture must be sustainable and support economic growth. Some of the policy interventions that should be provided should include the following, outlined by Ogunleye (2017):

Import substitution: this will discourage importation of products which Nigeria may have comparative advantage in their production and processing, save foreign exchange, encourage the local alternatives and hasten the attainment of self-efficiency. Nigeria should not be importing products like tomato paste/concentrate, tropical fruit concentrate, cassava derivatives, etc. Nigeria spends an estimated N18 billion annually on products like these. Import substitution policy should cater for investment in agriculture to the advantage of local production. Import substitution, as events presently suggest, is in the shadows because Nigeria still significantly imports even what it can produce locally with reasonable advantage.

Tariff and surcharge: when levied on some imported agricultural commodities will limit their importation and encourage domestic production and processing. Commodities like rice, sugar, maize, etc fall into this category. The tariff regimes will exert positive effect on the agriculture economy enhancing local production. These types of policies will falter if our borders remain as porous as it is today because smuggling and black market activities will negate whatever these policies aims to achieve. Moreover, the policies must be intelligently executed though to avoid a trade war that may impact the economy.

The Policy of Zero Duties on Agricultural Equipment and Machines will facilitate importation of needed agricultural equipment, machines and other accessories like tractors that are not produced and manufactured locally. This will reduce production and processing costs.

Contemporary realities suggest the acquisition of these tools remain prohibitive and out of the reach of the farmers that need them. Agricultural inputs to support the farmers especially the small scale farmers should be subsidized. This will reduce cost of production for the small holder farmers who plausibly are resource poor. The suggested inputs should include seeds and seedlings, agro chemicals, loans and credits.

The Place of Agriculture in Nigeria's Economic Growth and Development

Development economists have always considered how agriculture will contribute to a nation's economic growth. Some laid emphasis on agriculture in economic development and believes the development of an economy may depend on agriculture because agricultural productivity surpluses can diffuse throughout the entire economic system and networks of transactions. They see the agriculture sector as a base in the productive sector of an economy upon which all others depend (Olajide *et al*., 2012). In our own clime, we can see that Agriculture contributes to the development of the economy through industrial raw material provision, factor (input) availability, market contribution and foreign exchange (Kuznetz 1961; Mackie 1964; Abayomi 1997; Abdullahi 2002; World Bank 2007 in Olajide et. al., 2012). Agriculture is the largest economic sector in Nigeria with a dominant share in the GDP, employing more than 70% of the labour force and generating about 88% of non-oil foreign exchange (Olajide *et al*., 2012). Agriculture's primary relevance is the provision of food and manpower to the industrial economy. In Nigeria, it is a key sector and will remain crucial in our development continuum. Economic history confirms agriculture is fundamental and a pre-condition for economic growth, in many developing and developed countries.

Olajide *et al*., (2012) citing Iganiga and Unemhilin (2011), stated that using Cobb Douglas Growth Model with variables such as commercial credits to agriculture, consumer price index, annual average rainfall, population growth rate, food importation and GDP growth rate proved that federal government capital expenditure was positively related to agricultural output. Also Oji-Okoro (2011) employed multiple regression analysis to study the contribution of agricultural sector to the economic development and found a positive relationship between GDP, domestic saving, government expenditure on agriculture and foreign direct investment from 1986 to 2007. Further, using a time series data, the team reported that Lawal (2011) verified federal government's expenditure on agriculture for a thirty year period 1979 – 2009. The study also showed significant statistical evidence that the contributions of the agricultural sector to the nations GDP was in direct relationship. The empirical table below lays much credence to the report of the three some.

Table 2: Relationship of agriculture investment and Nigeria's GDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	13106.28	27745.31	0.472378	0.6393
OUTPUT	0.344909	0.007552	45.67056	0.0000
R-squared	0.991381		Mean dependent var	1571964.
AdjustedR² squared	0.991160		S.D. dependent var	2758148.
S.E.of regression	259327.3		Akaike info criterion	27.81712
Sum squared resid	2.62E+12		Schwarz criterion	27.90071
Log likelihood	-568.2510		Hannan-Quinn criter.	27.84756
F-statistic	4485.789		Durbin-Watson stat	1.267931
Prob(Fstatistic)			0.000000..................	

Source: Olajide et. al.,

The empirical results of the regression show a positive relationship between GDP and the Agro-outputs. From the result, a unit change in agricultural output caused a 34.4% change in GDP. The F-ratio of the study was about 4485.789 at 5 percent level of significance implying that the agricultural sector for the period under study had significant influence on the macroeconomic performance. From the ongoing it is evident that agriculture is one of the most important sectors in the economy. The capacity of agriculture to initiate economic growth and a sustainable development of the economy cannot be overemphasized. Agriculture can pave way for economic growth, guarantee employment opportunities, foreign exchange earnings and poverty reduction in the economy.

Conclusion

It is obvious that the agriculture sector can significantly contribute to Nigeria's GDP, grow and develop the economy. Literature, contemporary and empirical evidences are compelling enough to change our perceptions and orientation about the agriculture sector, it is no longer the ''ordinary farming business''. Though recent regimes have highlighted interests in agriculture in recent times yet, this is a far cry from what is adequate, more so, agriculture has all that it takes to turn the economy around (release of labour to the industries, provision of raw industrial materials, increased income earning capacity, access to foreign exchange, infrastructural development, etc) on a sustainable bases because it is inexhaustible unlike petroleum and other mineral and natural resources. Further, the multiplier effect on the economy is perpetual so long as the industry exists. Based on the findings, the study recommends a well articulated vision for the agriculture industry; it should be a front burner in our economic planning. Agriculture should be repositioned through mainstreaming for sustained growth and development. Easy to acquire credit should be made available to the smallholder farmers who are the main players in the agriculture industry. This is necessary to assist them to deal with the challenges associated with inadequate access to credit as this will affect production and output.

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Agripreneurship as a Tool for Improving the Agricultural Sector for Economic Development in Nigeria

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Abstract
This paper reviews and highlights problems facing the agricultural sector and agribusiness in Nigeria and in turn the overall economic growth and development. It further identifies agripreneurship as a remedy to current situation of underperformance plaguing the agricultural sector which will in turn lead to an overall economic growth and development. Agripreneurship will attract youth to the agricultural sector, create agribusiness growth and expansion, provide better options for farmers and improve the standard of living of farmers. Trend analysis was employed in terms of current and historical perspectives as well as descriptive analysis to evaluate the effects of agripreneurship on the agricultural sector. The paper made relevant recommendation that will enhance the creation of favorable business environment for agripreneurship in Nigeria.
Key Words: *Agriculture, Economic Growth and Development, Agripreneurship, Agribusiness*

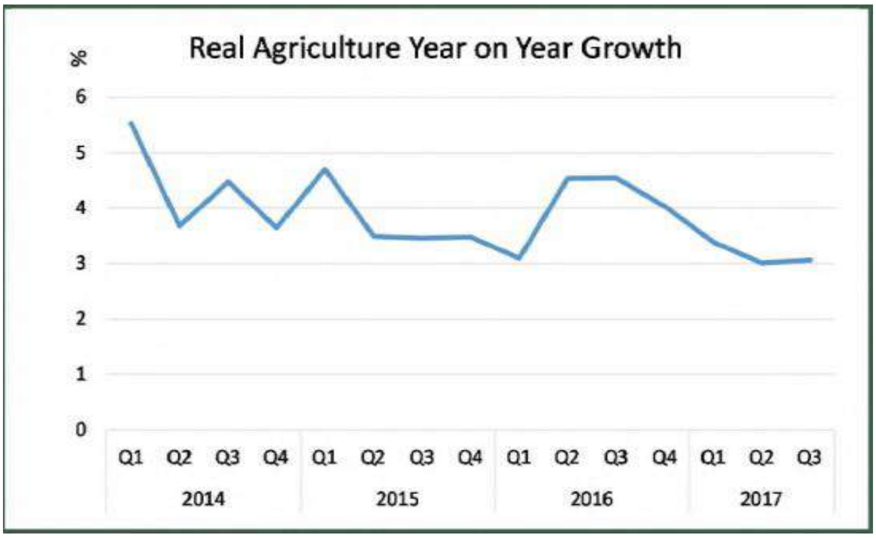
Introduction
Agriculture is very crucial to the Nigerian economy and the livelihood of the rural populace. It was the mainstay of the nation's economy prior to the discovery of crude oil. One of the sectors governments and policy makers turn to with regards to economic diversification is the agricultural sector; this is because of the numerous benefits and potentials inherent in the sector. Chukwuma and Uju (2013) stated that agriculture contributes the largest to non – oil foreign exchange earnings and can ensure output income and food security. Adeniran and Sidiq (2018) also described agriculture as one of the tools for pulling the Nigerian economy out of economic recession. According to the NBS, the agricultural sector is made up of four (4) subsectors namely: Crop Production, Livestock, Fisheries and Forestry. The sector is heavily dominated by Crop Production contributing for 91.27% of the overall nominal growth of the sector. Agripreneurship has been identified as the new solution to unemployment and food insecurity especially in developing economies. Uche and Familusi (2018) described agripreneurship as the combination of entrepreneurship and agriculture and that an agripreneur like an entrepreneur must be able to detect and create business opportunities that he or she can exploit. Bairwar *et al,* (2014) explaind that agripreneurship refers to agribusiness establishment in agriculture and allied sector. They also described an agripreneur as someone who undertakes a variety of activities in agriculture sector in order to be an entrepreneur.

Problems Facing the Agriculture Sector in Nigeria
In terms of economic development and contribution to industrialization, the Nigerian agricultural sector is still far from reaching its expected potential due to its failure to produce food beyond subsistence level despite the sector contributing 24.44% to the nominal GDP in the third quarter of 2017 (NBS, 2017). It still reflects a lot more work to be done in the sector. The underperformance of the agricultural sector can be attributed to the following (Yusuf, 2014),

- Overdependence on the Oil Sector - Yusuf (2014) affirms that the after the discovery of oil in Nigeria, the contribution of agriculture to the overall GDP fell from about 75 – 80% to about 40%. The discovery of oil gradually turned Nigeria into a mono – economy, heavily dependent on the sales of crude oil. The Nigerian economy was plunged into an economic recession in 2016. During the third quarter of 2016, the nation's GDP contracted by -2.24% (year-on-year) in real terms according to the NBS Report (2016). The NBS report stated that among other factors, a significant drop in the sale of oil was responsible for the drop in the real GDP leading to economic problems for the country.

- High Interest Rates and Poor Credit Facilities – The agricultural sector is usually faced with high interest rates making lending almost impossible. Furthermore, the collateral often asked by financial institutions is beyond the capacities of the rural farmers. The inability of farmers to access loans and credit facilities prevents them from expanding and growing their agricultural ventures.
- Environmental Issues – As environmental degradation occurs, agricultural activities take a steady decline. Furthermore, oil refining activities in the Niger Delta have resulted in oil spillage causing environmental damage. This has affected farming and fishing activities in the region.
- Poor Infrastructure – The absence of storage facilities has affected agricultural output due to the perishable nature of several agricultural produce. Furthermore, poor transportation facilities, poor electricity has not only disabled farming activities but also prevented the growth and expansion of the sector.
- Insecurity – Agricultural activities have been put to a standstill in regions affected by unwarranted killings and loss of properties. This has led to a remarkable drop in crop production and livestock practice in Nigeria.

Figure 1: Graph showing agricultural performance from Q1 2014 TO Q3 2017.



Source: National Bureau of Statistics Q3 Report

Eze (2017) added that the shift of attention from the agricultural sector to the oil sector led to problems and consequences such as food insecurity, import dependence, inadequate supply of raw materials to industries, excessive borrowing, high inflation and unemployment rates etc in the country.

Agripreneurship as A Way Forward in the Agricultural Sector

Agriculture as an enterprise is going through a transition globally, assuming a new shape and has gone beyond mere cultivation of crops and rearing of animals or an enterprise of the rural population (Uche and Familusi, 2018). They further added that agripreneurship will help in achieving Nigeria's Agricultural policy whose objectives includes job creation, food security, foreign exchange conservation and earnings as well as the enhancement of economic diversification. It is therefore important to employ more productive techniques into the agricultural sector in Nigeria.

Uneze (2013) stated that the need for agripreneurship stems from increasing demand of organic and quality food, competitive advantages for many primary production activities in agriculture, private sector willingness to enter into agribusiness at all levels of operation, to reduce malnutrition in women and children and to ensure household and national food security.

Agripreneurship views farming as an important venture, sees farmers as investors, provide opportunities for the growth of Small and Medium Scale Enterprises (SMEs), allow urban – rural intra and inter population participation in agribusiness, brings about sustainable and healthy business environment and its innovative approach increases effectiveness and efficiency in agribusiness. Agripreneurship is a viable tool for revitalizing the agricultural sector in Nigeria. This is also very important given the subsistent nature of farming being practiced by many farmers especially those in rural areas and the heavy emphasis being placed on entrepreneurship as an option for alleviating problems of unemployment in Nigeria.

Adeniran and Sidiq (2018) mention that the older population is the ones who are still heavily involved in agriculture as most youths leave rural areas to urban areas in order to find employment. Agripreneurship involves the use of modern farming techniques and machinery as well as an exposure into a vast agricultural value chain which allows for more output and income. These may attract more youths to venture into agribusiness. As more youths begin to join the agricultural sector and agripreneurship models are employed, rural – urban migration is curtailed, employment opportunities will further be created and the overall agricultural sector will improve. Most agricultural practices currently being used are restrictive and as such can only reach limited markets. However, with agripreneurship farmers can sell their products to a wider and bigger market. Farmers will also have increased farming options and may have better access to credit facilities that would otherwise have been absent or unavailable with subsistent farming. Agripreneurship further gives farmers the options of exploiting other points on the value chain and as such achieve expansion and growth of their agribusiness.

Nwibo, *et al,* (2016) maintain that at input production level, there are many potential agripreneurial opportunities such as bio-fertilizers, bio-pesticides, soil amendments, plants of different species of fruits, vegetables, ornamentals, roots media for raising plants in pots, mineral mixture and complete feed. There are also agripreneurial opportunities to support sericulture, fishery and poultry. Agripreneurship can also serve as a means of improving the standard of living of farmers especially those in rural areas. By employing agripreneurship techniques, farmers will be able to create a wide range of products and services from their agribusiness. This will lead to an increase in income and earnings leading to a rise in standard of living. This may eventually lead to the development of such rural areas.

The application of entrepreneurship skills and principles in agriculture may give rise to more agro-allied firms that will create new products using agricultural output as raw materials. These new products will make Nigerian exports compete better in the international market therefore creating foreign exchange earnings. Entrepreneurship breeds competition and as such employing these techniques in agriculture will create healthy competition among farmers leading to better agricultural output at lower prices ensuring food security.

Recommendations and Conclusion

Given the already existing and potential roles agripreneurship can play in revitalizing the agricultural sector, governments and policy makers need to create specific policies aimed at promoting agripreneurship in Nigeria. By actively conducting trainings in schools and other institutions in Agripreneurship Education, providing credit facilities to existing and potential agripreneurs, creating better infrastructure that will support the growth and development of the agricultural sector and tackling insecurity, government can create a good environment for agripreneurship to thrive in Nigeria. Hence, the agricultural sector would be revived and in turn contribute positively to economic growth and development Nigeria.

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Socioeconomic analysis of Processors and Users of Camel (*Camelus Dromedrius*) Products in Yobe State Nigeria

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Abstract
The research was conducted to evaluate camel production, the different products obtainable from camel (Camelus dromedrius) and their utilization in Yobe State. A design questionnaire was used to collect the required information. Stratified random sampling technique was used to sample 113 respondents from the study area. The results showed that over 95% of the total respondents consumed camel meat and about 82% of the respondents were engage in marketing of camel meat. About 54% believed that cooking is the most common method of processing camel meat. Over 70% of the respondents consumed camel milk and about 64% of the respondent involve themselves in marketing of camel milk. 33% of the respondents do not consider camel urine for medicine or any consumption but about 51% used it for medicinal purposes. Furthermore, the result indicates that 77% of the respondents used camel hide domestic purposes and over 50% of the respondents were involved in the marketing of camel hide. Meat, Milk, hide and Urine are the major products obtained from camel in the study area and they are extensively utilized in the area.
Key words: *Camel, meat, market, processing, milk, hides*

Introduction
Camels are pseudo ruminant animals that have either one hump (Arabian camel) or two hump (Bacterian camel), which play an important socio-economic role within the pastoral and agricultural system in dry and semi dry zones of Asia and Africa (Berhanu et al., 2013 and Gwida et al., 2011). Global population of camel was estimated to be around 20million of which 15million are found in Africa and 4million in Asia (Farah 2004 and Jaji *et al.,* 2017). Rearing of camel in Nigeria is for various purposes like carrying farm products, milk, meat, and hides production and to some extent camel is used for racing especially in the Middle East countries (Jaji *et al.,* 2017). They are also a reliable source of milk during dry season and draught when milk from other animals like goat, sheep and cattle become scarce and there products play a vital role in nutrition and medicine for the people in eastern Africa (Farah 2004, Farah et al., 2007 and Jaji *et al.,* 2017). Camels are known to be drought tolerant animal due to their unique physiological features that help them to survive and produce under harsh environmental conditions by regulating the body temperature to changes in ambient temperature (Berhanu et al., 2013). Camelus dromedrius are mostly found in arid and semi-arid areas of Africa, found in the countries like Somalia, Sudan, Ethopia, Kenya and Djibouti (Gebisa, 2015). Camel are also found in Nigeria mostly in the northern part of the country including Borno, Yobe, Kano Jigawa, Katsina, Sokoto Kebbi and Zamfara state. An increase in camel population within Nigeria was reported to be about 90,000 in 1994. The increase in camel population was believed to be due to the disease outbreak in cattle range that decrease the supply of cattle meat in the country and may also be due to the affordability, as camel meat is cheaper than cattle meat (Jaji *et al.,* 2017 and Abubakar *et al.,* 2010).

The casual use of the camel as draught animal was reported by Musa (1990). The camel is, however increasingly becoming important in primary land preparation and secondary field operations during the rainy season (Jaji *et al.,* 2017). Farmers in the Northern States are exploiters of camels rather than producers, since the camels are an essential part of the pastoral daily life. They are important for the pastoralists to be recognized as a true member of the community (Kaufman and Binder, 2002). Camels not only sustain life on a day-to-day basis for many people living on the fringe of subsistence, but also serve as depository of wealth and a security against unknown future

(Wilson, 1998). Meat is importantly required by all human beings to have enough supply of animal protein in their body as deficiency can lead to certain nutritional diseases and reduce disease resistance (Olusiyi *et al.,* 2014). Camels are also considered as good meat producers in Sub-Saharan Africa (Kurtu, 2004) and in areas where the climate adversely affects other animals and cannot provide the required amount of meat needed. The male dromedary carcass can weight 400kg or more (Knoess, 1977). The carcass of a male Bactrian can weigh up to 650kg. The carcass of a female camel weighs 250 and 350kg.

Tasfemariam *et al.,* 2017, reported that, camel milk contain higher whey protein to casein ration compared to bovine milk which is responsible for a soft and easily digestible curd in the gastrointestinal tract. Camels are good producers of milk in the dry regions. Apart from their use for luggage, their milk is good for child health improvement (Yagil and Etzion, 1980; Wilson, 1988). Camel milk is staple food of desert nomad tribes and is richer in fat cow milk. Camel milk cannot be made into butter in the traditional churned method. It can be made if it's first churned, and then a clarifying agent is added, at 24-25° C, but times will vary greatly in achieving results. The milk can be made into yoghurt. Butter or yoghurt made from camel milk is said to have greenish tinge. Camel milk has many healthful properties and is used as a product; some tribes believe that camel milk has great curative powers if the camel`s diet consists of certain plants (Nowak, 1991). Despite the numerous advantages drawn from camel, there is still need to carry out research on processing and utilization of camel products in northern Nigeria. Therefore the current study was aim to assess the processing and utilization of camel products in Yobe State Nigeria.

Methodology

The study was conducted in Yobe state, a Muslim dominated state. The state lies between longitude 12° 00' and a latitude of 11° 30'. The annual rainfall varies from 500 mm to 1000 mm and the rainy season is usually from June to September, with flooded pastures towards Lake Chad and Montane regions in the extreme southeast (Jaji *et al.,* 2017). Three LGAs (Damaturu, Geidam and Yunusari) out of seventeen were purposively selected due to their high level of engagement in processing and utilization of camel products. A total of 113 respondents were selected after a pre-test, using stratified random sampling technique for the study (Gupta, 2002; Pagano and Robert, 1990). Data was collected with a questionnaire administered by trained field staff and analyzed using descriptive statistics.

Result and discussion

Socioeconomic analysis

The results revealed that 80% of the people engaged in processing of camel products were males (Figure 1) with only 19% of female respondents. Less female members were involved in the activities of processing and marketing of camel products. This is attributed to culture and religion of the people in the area, which restrict female participation to household chores. This is supported by the findings of Hassan *et al* (2006) who found that most of the people engaged in poultry processing in the northern part of the country were males.

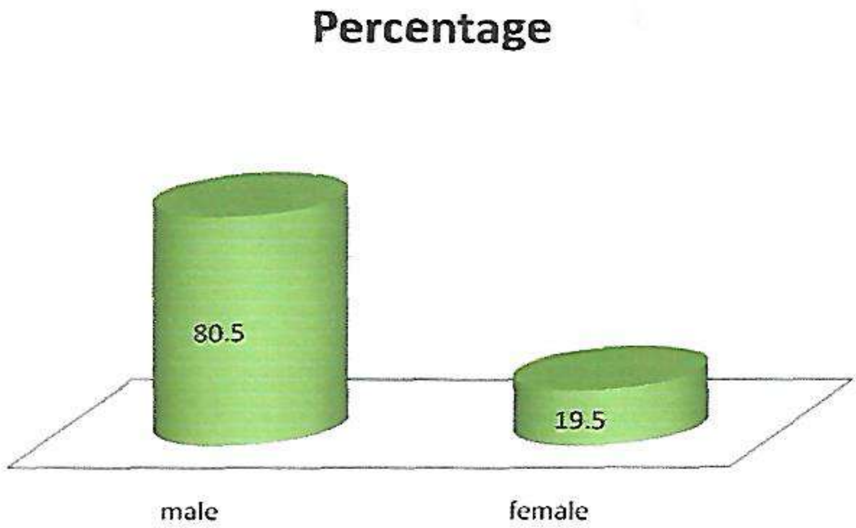

Figure 1: Distribution of respondents by sex

Majority (93%) of the respondents fell within the range of 20 to 40 years. Only 7.07% of the respondents fell within 41 to 50 years. This is in line with the report of Muhammad and Kibon (2006) of age range between 28 and 61 years for respondents in Borno. This indicated most (93%) of the respondents were in their active age, that is, they are energetic enough for the processing of camel products. Older people are likely to participate in community development projects and farm practices due to old age, but the youth are stronger, they can participate in all agricultural activities. This supports the findings of Yusuf *et al.,* (2002)

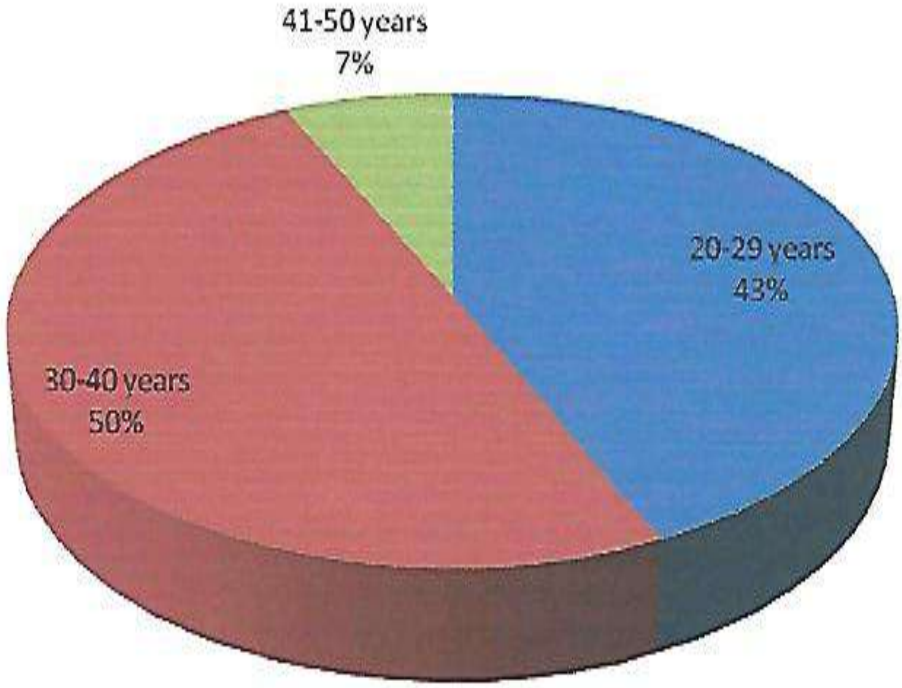

Figure 2: Age distribution

About 32.74% of the respondents were single, 44.2% married, 13.2% widowed and 10% divorced. These results indicated that most of the respondents in processing and utilization of camel products were married men and women in a stable family system. Only a few were widowed and divorced, which exert social pressure on family members. The findings were similar to the reported values of Muhammad *et al.* (2006). Most (49.55%) of the respondents had families with only 1-3 children, 12.38% had between 4-6 children, only 6.19% had 7-10 children. The results indicated that majority of the respondents in the study area had newly established families. Family size is a very important factor in the individual economy and it characterizes the expenditure and labor for most activities (Yusuf *et al.* 2002). The results showed that the majority (51.3%) of the respondents were butchers and 12.4% farmers. The civil servants among the respondents were 16.8%, while 19.5% were meat processors. Female respondents mostly process meat at home and later convey it to the markets. Camel farmers were involved in activities of camel products processing and often utilized the products. The civil servants among the respondents were mostly meat inspectors and veterinarians at abattoir.

Table 1: Distribution of the respondents by marital status, family size, occupation with Sources and preferred sexes of camels

Marital status, family size and occupation			**Sources and preferred sexes of camels**		
Parameters	**Freq.**	**%**	**Parameters**	**Freq.**	**%**
Marital status			**Source of camel**		
			Niger republic	18	15.90
			Bulaburin	60	53.10
Single	37	32.74	Gumsa	35	31.00
Married	50	44.24			
Widow	15	13.27	**Preferred Camel Sex**		
			Female	7	6.20
Divorced	11	9.73	Male	56	49.60
Total	113	100.00	No preference	50	44.20
			Total	113	100.00
Family size					
1-3	56	49.55			
4-6	14	12.38			
7-above	7	6.19			
Total	113	100.00			
Occupation					
Farmer	14	12.40			
Butcher	58	51.30			
Civil servant	19	16.80			
Meat processor Total	22	19.50			
	113	100.00			

Table 1 also shows the distribution of the respondents based on their sources of camels. Majority (53.1%) of the respondents sourced their camels from Bulaburin *market* while 31.0% were from Gumsa market and 15.9% were from Niger Republic. Also, the results showed that the most preferred camel for slaughter by the respondents were male camels (49.63%), while 44% showed no preference to sex of camels for slaughter, only 6% of slaughtered Camels were females. Majority of the people living in the study area (77.9%) required the services of others to achieve efficient processing of the camel products, especially in the processing of camel meat for hiring meat handlers (62%). However 20% did not require aid from the third party to conduct their activities. The services of butchers and relatives were sought by 14% and 24% of the respondents, respectively. The use of family members and friends provide cheaper source of labor to camel producers (personnel communication, 2008).

Table 2: Use of hired services, Camel meat consumption & marketing, Use and marketing of camel hide by the respondents

Hired services			**Camel meat consumption & marketing**			**Camel Hide**		
Parameters	Fre	%	Parameters	Fre	%	Parameters	Fre	%
			Consumption			**Utilization**		
Use hired service	88	77.9	Yes	108	95.6			
Do not use hired service	25	22.1	No	5	4.4	For Food	43	38.1
Total	113	100	Total	113	100	Bags	14	12.3
Services Hired			**Processing**			Shoes/belts/Whip/ Saddle	30	26.5
Butchers	14	14	Frying	31	27.4	Do not use hide	26	23.1
			Cooking	62	54.9			
			Roasting	20	17.7			
			Total	113	100			
Meat handlers	62	62	**Marketing**			Total	113	100
			Yes	93	82.3			
Relatives/friends	24	24	No	7	6.2	**Hide marketing**		
Total	113	100	Total	113	100	Yes	67	59.3
						No	46	40.7
						Total	113	100

Most (96%) of the respondents consumed camel meat as shown in table 2 only 4% reported none consuming camel meat, which they associated with ill-health. The results indicated that camel meat is highly consumed in the area and was related to availability and high protein content (Kurtu, 2004). Majority (54.9%) of the respondents considered cooking as the common method of camel meat processing.

About 27% of the respondents considered frying as the most common method, while 17.7% considered roasting as the most common method. These three methods are the commonest means of food processing in the study area. The results indicated that majority of the respondents in the study area considered cooking as method of processing camel meat due to ease of cost compared to roasting and frying, heat treatment effects a number of nutrients contents of meat especially protein. The results further showed that majority of the respondents (82.3%) were involved in marketing of camel meat. Only 6.2% of the respondents were involved in other activities than camel meat marketing. The result indicated that camel meat marketing is a highly valuable activity in the study as it provides good source of income (Personal Communication, 2008)

Again, majority of the respondents (76.8%) used camel hide for one product or the other, of which 38.1% used it for food. About 22% did not use camel hide at all. Likewise, 59.3% of the total respondents were involved in marketing of camel hide while 40.7% were not. Majority (38.1%) of the respondents used camel hide as food. Hide is a valuable commodity used for making a number of products by the respondents; these include bags (12.3%); shoes, belts, whip, saddles (26.55), in the study area. EI-Amin (1979) was of the opinion that in general camel hide provides a good source of income and used for shoes and sandals among other useful materials.

Table 4 shows the distribution of the respondents based on camel milk consumption, marketing and Urine use. Majority (74.3%) of the respondents consumed camel milk while 25.7% did not due to one reason or the other. The results further showed that the most common milk products consumed by the respondents were fresh milk (52.2%) and cheese (47.7%). Majority of the respondents (64.6%) were involved in the marketing of milk. Most of the respondents were involved in the milk marketing to generate more income.

Table 4: Camel milk, marketing and Urine

Camel milk and marketing			Camel Urine		
Parameters	**Freq.**	**%**	**Parameters**	**Freq.**	**%**
Camel milk consumption			**Utilization of camel urine**		
Yes	84	74.3			
No	29	25.7	Yes	33	29.20
Total	113	100	No	80	70.80
Camel milk products			Total	113	100.00
Fresh milk	59	52.2			
Cheese	54	47.7	**Use of camel urine**		
Total	113	100	Medicine	16	51.60
Marketing of camel milk			Spiritual activity	15	48.40
Yes	73	64.6	No response	82	72.50
No	40	35.4	Total	113	100.00
Total	113	100	**Camel urine processing**		
			Yes	17	15.00
			No	96	85.00
			Total	113	100.00

Approximately, 70% of the total respondents were not using camel urine for any purpose. However, 29.2% used camel urine for medicinal (51.6%) and spiritual activities (48.4%). Almost all 85.0% of the respondents reported not processing the camel, while 15.0% claimed that the urine is subjected to some processing before use.

Conclusion

The socio-economic environment of the study area was homogenous. The camel meat, milk, hide and urine were the products used extensively. The male camels were most preferred for slaughter and marketing of the camel meat and hide was a major engagement in the study area. Also, fresh camel milk was mostly used for cheese making while the camel urine was used for medicinal purposes. Therefore great benefit could be achieved through improving the processes of utilizing camel products in the study area. It is an important source of protein as well as a beast of burden. It is therefore recommended that further investigation into the method of processing and utilization of camel products should be conducted. The nutritional and chemical qualities of products should be evaluated and Camel producers and consumers of the products should be encouraged to form User Group and Cooperating Societies for maximum benefits.

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Use of Cassava Flour and profitability of Buns for Poverty Alleviation among Rural People in Etche Ethnic Nationality, Rivers State, Nigeria

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Abstract

The study investigated marketing of cassava flour for poverty alleviation among rural people in Emohua Local Government Area of Rivers State, Nigeria. Primary data were collected through structured questionnaire. A total of 50 respondents were purposively selected and employed for the study. Data collected were analyzed using mean scores and percentage. The results showed that majority (42.00%) of the respondents were within the age range of 41 to 50 years, married (80.00%) and are females (64.0%). More (38.0%) had secondary education, have been involved in cassava flour business for 6-10 years (46.0%), and are full time farmers (88.0%). A good proportion (37.31%) of the respondents accepted that buns were the major product produced from cassava flour in the area. A total variable cost (TVC) of N1, 560 was needed to realize total revenue (TR) of N2, 800 giving a profit of N1, 240. The ways cassava flour marketing alleviate poverty are: it served as additional source of income (20.0%) and a source of livelihood (26.0%) to rural people. The constraints to marketing of cassava flour are: longevity (x=3.18), method of preparation (x= 3.20) and non-acceptability of the product in the market (x=32). The study recommends that government should popularize the use of cassava flour in baking and confectionary products
Keywords: *Cassava flour, poverty alleviation, rural people*

Introduction

Cassava is one of the most productive root crops in the tropics in terms of yield per hectare. It belongs to the genus *Manihot* of the natural order *Euphorbiacea*. It is said to have been introduced from Brazil as its original home to West Africa by the early Portuguese explorers (Kassan, 2001). The two main kinds of cassava commonly grown in West Africa are the sweet cassava (*Manihot palmet*) and bitter cassava (*Manihot utilisima*). The bitter cassava contains a bitter juice that must be extracted before it is considered safe for food. The varieties of cassava differ in their stem, skin, leaf, petals, colour and time it takes to mature and in quantity of the tuber. Apart from being a staple crop in both rural and urban households, cassava is a major source of income to cassava farmers and processors in the rural areas. Cassava production alone contributes about 45% of agricultural GDP in Nigeria for food or domestic purposes (IITA, 2005). However, its industrial processing and utilization has been very limited. Cassava is recognized as one of the staple foods in Nigeria. Most farmers in Emohua Local Government Area of Rivers State are cassava producers due to the massive land and the soil suitable for cassava production. Cassava tubers can be processed to cassava flour which can serve or be used as a substitute for wheat flour which is used to prepare bread, meat-pie, cake and other flour related food products. The use of cassava flour will reduce the price of bread, meat-pie and other by-products of flour in the market.

Recently, the price of wheat flour is high which has affected the prices of bread, doughnut and other food products from flour. Flour for baking is mostly imported into the country from other neighbouring countries. The ban on importation affected the price of wheat flour and its related products. Therefore, cassava flour can be used by rural people as substitute for wheat flour to produce bread, meat-pie, cake, Chin-chin, buns etc and it becomes a source of livelihood to them since cassava is common in the area, and it could easily be processed into cassava flour. It is on this note that this paper seek to find out how marketing of cassava flour would help to alleviate poverty among rural populace with the following objectives:

(i) describe the socio-economic characteristics of the respondents;
(ii) identify the different types of products from cassava flour;
(iii) determine the profitability of cassava flour of some products;
(iv) ascertain benefits from cassava flour and how it will reduce poverty; and
(v) identify the constraints to the use of cassava flour among rural people in the study area.

Methodology

The study was conducted in Etche ethnic nationality. The Etche ethnic group is made up of two Local Government Areas, namely Etche and Omuma, respectively. Etche is made up of five clans while Omuma is made up of four clans. They are predominantly rural and agrarian in nature. The respondents in the study were selected using multi-stage sampling techniques. Firstly, the study area was divided into five clustered (clans). Secondly, two communities were purposively selected from each clan, giving a total of ten communities. Thirdly, five cassava processors/ users of cassava flour were purposively selected from each community because they are few, giving a total of 50 respondents which was used for the study. Primary data were gathered through the administration of structured questionnaire for those who could not fill the questionnaire. The data collected from the field were analyzed and interpreted through the use of percentages and mean statistics. Gross margin analysis was used to determine the cost and returns on cassava flour of buns/doughnut. Gross margin is given as:

$$GM = TR - TVC$$

Where:
GM = Gross margin
TR = Total revenue
TVC = Total variable cost

Results and discussion

Socio-economic Characteristics of the Respondents

The age of the respondents as shown in Table 1 reveals that a higher number (42%) of the respondents were within the age bracket of 41 to 50 years with a mean age is 46.3 years. Majority (64%) of the respondents were females. This shows that there are more female involved in cassava flour processing business than men in the area. This also agrees with the findings of Albert *et al* (2017) that women are mostly involved in cassava processing business. Majority (80%) of the respondents were married. Also marriage gives people the sense of responsibility to provide the basic needs of the family (Albert *et al* 2014). All the respondents attained a level of education. This indicates that the respondents were literates, they can read and write.

Table 1: Socio-economic characteristics of the respondents

Characteristics	Frequency	Percentage	Mean
Age (years)			
21-30	3	6.00	
31 – 40	9	18.00	46.3 yrs
41 – 50	21	42.00	
51 – 60	15	30.00	
61 & above	2	4.00	
Total	50	100.00	
Gender			
Male	18	36.00	
Female	32	64.00	
Total	50	100.00	
Marital Status			
Single	4	8.00	
Married	40	80.00	
Divorced	2	4.00	
Widower/Widow	4	8.00	
Total	50	100.00	
Level of Education			
No formal education	3	6.00	
Primary education	18	36.00	
Secondary education	19	38.00	
Diploma	7	14.00	
University education	3	6.00	
Total	50	100.00	
Years of Experience			
1 – 5	12	24.00	
6 – 10	23	46.00	9yrs
11 – 15	10	20.00	
16 above	5	10.00	
Total	50	100.00	

Source: Field Data, 2017

Products from Cassava Flour

The types of products from cassava flour as shown in Table 2 shows that most (37.31%) of the respondents accepted that buns was the major product they produce from cassava flour in the area. About 22.39% and 14.92% produced doughnut and chin-chin, respectively from cassava flour. An equal percentage (8.95%) of the respondents produced bread and cake from cassava flour. The implication is that majority of the respondents produce buns from cassava flour as a source of business. This is because buns are cheap and accepted by both adults and children who buy it as snacks.

Table 2: Types of products from cassava flour (Multiple Responses)

Types of Products	Frequency	Percentage
Bread	6	8.95
Chin-chin	10	14.92
Doughnut	15	22.39
Cake	5	8.95
Meat pie	5	7.46
Buns	25	37.31

Source: Field data, 2017

Profitability of Buns from Cassava Flour

The result in fig 1 shows that the variable cost (TVC) needed to produce 56 buns was ₦1, 500.00. The total revenue (TR) realized from it was ₦2,800 indicating a gross margin (GM) of ₦1,240.00 indicating that cassava flour business is profitable.

Total Variable Cost (TVC)		
Cassava flour	1 Custard rubber	700.00
Groundnut oil	1 Small Eva rubber	350.00
Sugar (grinded)		50.00
Nutmeg	1 sachet	50.00
Yeast		100.00
Butter	1 packet	100.00
Salt	1 wrap	10.00
Firewood		200.00
Total Variable Cost (TVC)		₦1,560.00
Total Revenue (TR)		
1 rubber of cassava flour will produce 56 buns at ₦50 per buns = 50x56		
Total = ₦2,800		
GM = Total Revenue (TR) – Total Variable Cost (TVC) = ₦2,800 – ₦1,560		
GM = ₦1,240		
Total Revenue (TR) = ₦2,800 – ₦1,560 = ₦1,240		

Fig 1: Profitability ratio of buns from cassava flour

Perceived ways cassava flour alleviate poverty in the study area

Table 3 shows that most (26%) of the respondents accepted that cassava flour was a source of livelihood. This implies that when the products are marketed it can be used to pay children's school fees, pay rent and improve the livelihood of the people in the study area. About 20% also went into cassava flour as it serves as additional source of income. This indicates that apart from other agricultural activities, going into cassava flour business was an added advantage to the people in the area. Cassava flour business as a source of livelihood for rural women, employment opportunity for those selling and an additional source of income to people involved in it, reduces poverty in the area.

Table 3: Ways cassava flour alleviate poverty in the area

S/N	Effects	Frequency	Percentage
1.	Reduces the money use to buy wheat flour	6	8.00
2.	Source of livelihood for rural women	20	26.00
3.	Additional source of income	15	20.00
4.	Provides easy snacks at home for rural people	7	9.33
5.	Source of employment for those selling	10	13.33
6.	Low in calories, fat and sugar	5	6.67
7.	In expensive, sustainable and easy to grow	12	16.00

Source: Field data, 2017 **Multiple Responses**

Constraints to the use of Cassava Flour

Among the various constraints to the use of cassava flour in the study area, non acceptability of the product in the market, method of preparation, storability, non availability of product in the markets, taste and fear of consumption of bread and confectionary products made from cassava flour appeared more prominent as shown in table 4 below.

Table 4.5: Constraints to the use of cassava flour among rural people

S/N	Constraints	Total Score	Mean Score (x)
1.	Taste	150	3.00
2.	Method of Preparation	160	3.20
3.	Longevity	159	3.18
4.	Non-availability of cassava flour in the market	152	3.04
5.	Non-acceptability of the product in the market	166	3.32
6.	Fear of consumption of bread and confectionary products made from cassava flour	150	3.00
7.	Government not adequately popularizing the use of cassava flour in baking and confectionary products	146	2.92

Source: Field data, 2017 $\geq$ 2.50 = Serious Constraints

Conclusion and Recommendations

High proportion of the respondents had buns/doughnut as their major product produced from cassava flour in the study area while few of the respondents produced meat pie from cassava flour. Cassava flour business was very profitable in the study area. It helped to reduce poverty in the area, as rural people have enough money to pay their children's schools fees, provide the basic needs of life for their households. Based on the findings of this study, it is recommended that government should popularize the use of cassava flour in baking and confectionary products through trainings for the rural women.

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Investigating acceleration, deceleration and stagnation in rice production, import and consumption in Nigeria (1970-2016)

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Abstract
The study was carried out to examine acceleration, deceleration or stagnation in rice production, import and consumption in Nigeria from the period 1970 -2016. Secondary data were collected from the USDA, FAO, IRRI and CBN. Exponential trend equations were fitted to examine their patterns of growth. The results show that over the period of 1970 – 2016, the production, importation and consumption of rice in Nigeria increased at compound rates of growth were 5.55%, 12.30% and 6.40% respectively within the period under review. However, the quadratic time trend equation indicated a declarative growth in rice production, import and consumption. It was recommended that the process of deceleration in rice production be revised by intensifying research in order to improve rice production technologies significantly in a way that the rate of growth would achieve the needed self- sufficiency in domestic rice production and thereby reducing the amount of money spent in rice imports in this country.
Keywords: *Growth Rate, Rice, Production, Import, Consumption*

Introduction
Rice is a leading staple crop in Nigeria cultivated and consumed in all parts of the country. Its domestic supply therefore has a great implication for food security and self-sufficiency in the country. Rice production rose gradually over the years with area expansion to surpass major rice producing countries like Cote d'Ivoire and Sierra Leone (Ayanwale *et al*, 2011). The reality is that Nigeria has not been able to attain self-sufficiency in rice production despite increasing hectares put into production annually (CBN, 2012). On the other hand, the demand for rice has been soaring over the years (Ayanwale *et al*, 2011). Since mid-1970s, rice consumption in Nigeria has risen tremendously growing by 10.3% per annum, a result of accelerating population growth rate, increasing per capita consumption, rapid urbanization, increased income levels, and associated changes in family occupational structures (Ayanwale *et al*, 2011; Akpokodje *et al*., 2001; Akande, 2002). About 3 billion people eat rice everyday with Nigerians consuming over 3.5 million metric tons per annum (Ayanwale *et al*, 2011)

Based on an estimated annual rice consumption of 6 million metric tons, an average Nigerian consumes 32 kg per annum, which is consistent with the USDA estimates from the early 2000s (USDA, 2000). This consumption is higher in the urban areas, averaging 47kg/annum, (USAIDS, 2012) representing 9% of annual calorie intake (IRRI, 2012). The recognition of rice as a major source of calories for the urban poor in Nigeria stimulated an increase in consumer demand above domestic production. Paradoxically Nigeria is also the second largest importer of rice in the world (Binuomote *et al*., 2012). The annual demand for rice in the country is estimated at 5 million tons, while production level is 3 million tons of milled rice resulting in a deficit of 2 million tons. The per capita household consumption of rice in Nigeria ranges between 3.5kg and more than 14kg per year (Nkang *et al,* 2005). Akpokodje *et al,* (2001) contended that the resultant effect of the increase in consumer demand is the massive importation of the commodity in the pre-devaluation (1975–1985) period, thus lowering the price of domestically produced rice with its attendance on poor farmers who now see reasons why they shouldn't go into rice production. Over the years the country had resorted to imports to bridge this deficit as reported by Ayanwale *et al* (2011).

However, several governments in Nigeria in the past and present have put in place quiet a number of progammes (Back to farm, Green Revolution, Operation Feed the Nation, etc) in a bid to improve agricultural productivity and encourage domestic production of her food. It is worrisome to note that in Nigeria, food demand have not kept pace with supply in virtually all the food types
.
This study empirically investigated the hypothesis of growth rates in rice production, import and consumption in Nigeria, 1970-2016. Specifically, this study analyzed (1) the trend in rice production, imports and consumptions in Nigeria within (1970 – 2016) ;(2) estimated the compound (over period of time) rate of growth of rice production, imports and consumptions in Nigeria within the reference period and (3) investigated the hypothesis of acceleration or deceleration or stagnation in the growth processes of rice production, imports and consumption in Nigeria within the period under study

Methodology

This study was carried using available secondary data for Nigeria from USDA, FAO, IRRI and CBN. Data on milled rice production, import and consumption were collected from the United States Department of Agriculture Foreign Agricultural Service (USDA, 2014). The data covered a period of fifty four years, 1970 to 2016. Objectives were realized with exponential trend or log-linear trend in line with Onyenweaku (2004) and Diebold (2004) exponential trend or log-linear trend equation for the quantity of rice production, imports and consumption in Nigeria is modeled as follows;

$$InRp_t = \beta_0 + \beta_1 t + \mu_t \quad (1)$$
$$In\ Ri_t = \beta_0 + \beta_1 t + \mu_t \quad (2)$$
$$InRic_t = \beta_0 + \beta_1 t + \mu_t \quad (3)$$

Where,
$InRp_t$ = quantity of domestic output of rice (measured in metric tons) at period t.
$In\ Ri_t$ = quantity of rice imports (measured in metric tons) at period t.
$In\ Ric_t$ = quantity of quantity of rice consumption (measured in millions of naira) at period t.
β_0 = the constant in the regression line, β_1 = the trend coefficients. t = trend variable measured in years. μ_t = the error term.

Objective 2 was realized using instantaneous growth and compound growth models. The models are specified as:

The instantaneous (at a point in time) growth model is given as;
$$\text{Growth rate} = \beta_1 Yt \times 100 \quad (4)$$

Where,
$\beta_1 \overline{Y}$ = relative change in quantity of rice output, imports and consumption respectively (trend coefficient);
t = trend measured in years

By multiplying the relative change in quantity of rice output, imports and consumption respectively by hundred, we obtained the percentage change or the growth rate in quantity of rice output and imports for an absolute change in time. After the estimation of equation (4) for instantaneous (at a point in time) growth rate of rice production, imports and consumption, the compound rate of growth was computed in line with Onyenweaku (2004), Gujarati and Porter (2009) as:

$$r = (e^{\beta} - 1) \times 100 \quad (5)$$

Where,
e = Euler's exponential constant (2.71828) (Sawant, 1983).
β = estimated coefficient in equations (1), (2) and (3) respectively

Objective 3 was realized using log quadratic trend equation. The log quadratic trend equation is fitted as;

$$InRp_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \mu_t \quad (6)$$
$$InRi_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \mu_t \quad (7)$$
$$InRiv_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \mu_t \quad (8)$$

Where,
β_2 = estimated parameter.
All variables as previously defined.
A positive significant value of β_2 indicates acceleration while a negative significant value of β_2 entails a deceleration. Stagnation in the growth process is explained by a non- significant value of β_2. i.e If $\beta 2 > 0$ and statistically significant, then there is acceleration in growth, If $\beta 2 < 0$ and statistically significant, then there is deceleration in growth. If $\beta 2$ is positive or negative but not statistically significant, then there is stagnation in growth (Oyenweanku, 2004)

Results and Discussion

Graphical Presentation of Trend in Rice Production, Imports and Consumption in Nigeria between 1970 and 2016
is shown in Figure 1

Rice Output, Imports and Consumption (1970 -2016)

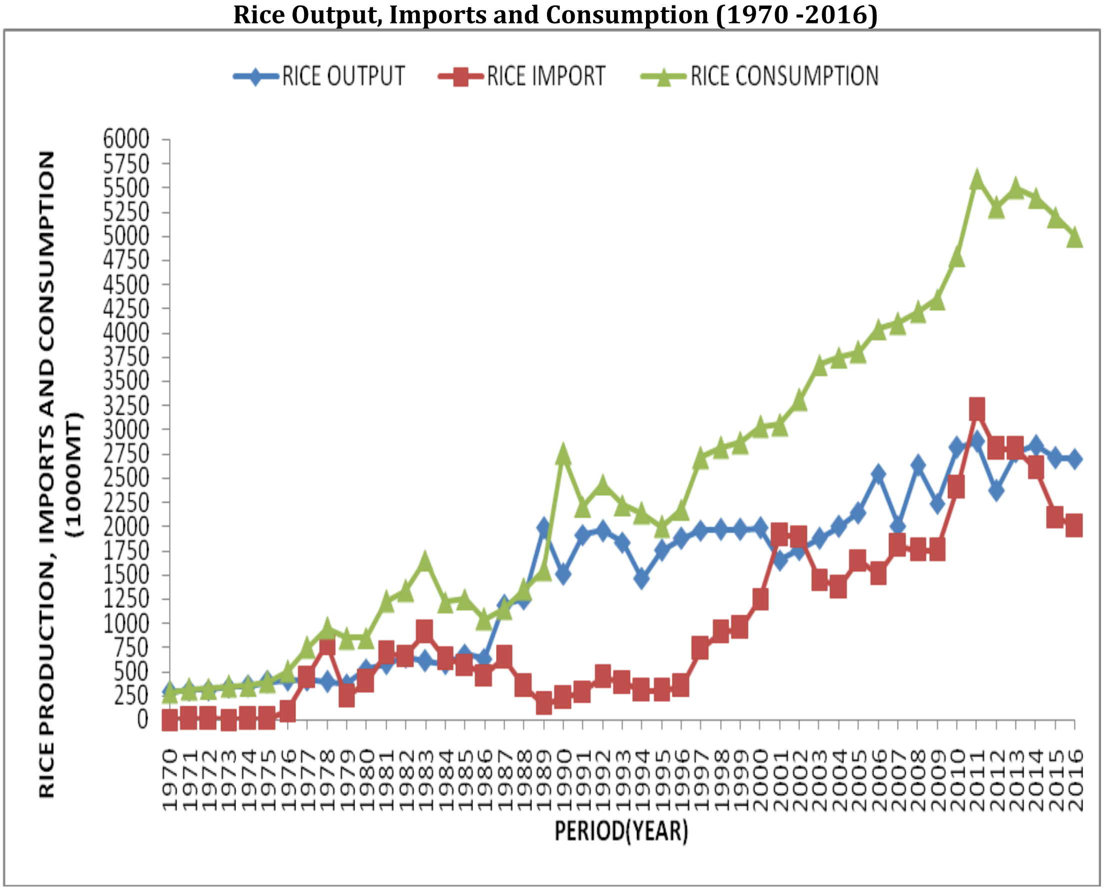

Figure 1: Trend in Rice Production, Imports and Consumption in Nigeria between 1970 and 2016

The trend lines and data for rice production, imports and consumption in Nigeria from 1970 to 2016 are presented in Figure1. It could be seen from Figure 1 that the estimates are not consistent as they do not show steady increasing or decreasing trend over the period. This confirmed that between 1970 and 2016, the quantity of rice production and imports increased and decreased severally overtime except for that of consumption that somewhat had a seemly increasing trend. The inconsistent trends of the rice production, import and consumption over the period under study could be among other things, due to the interest of the Government ruling at any particular period. It implies that there was no consistency and continuity of programmes of action by the successive Governments in this direction. The expectation is to see a pattern that will show an increasing trend over the period as an indication of a growing economy. The inconsistency and lack of continuity of various Government programmes in most cases according to Okolo (2004) accounted for the poor outcome of the programmes.

Trend equations for quantity of rice produced, imported and consumed in Nigeria (1970 - 2016)
Data were subjected to analysis using the exponential growth equations to examine the holistic percentage change in rice production and importation within the reference period. The result is presented in Table 1 below.

Table 1: Estimated exponential trend equations for quantity produced and imported of rice in Nigeria (1970 -2016)

Dependent Variable	β_0	β_1	R^2	F-ratio
Rice output	5.832 (73.151)***	0.054 (17.931)***	0.877	321.513***
Rice imports	3.351 (9.398)***	0.116 (8.651)***	0.625	74.842***
Rice consumption	6.066 (82.793)***	0.062 (22.750)***	0.920	517.558***

Source: Computed from time-series data, 1970-2016 Note: *** implies statistically significant at 0.01probability level.

Table 1 shows that quantity of rice production, quantity imported of rice and quantity consumed in Nigeria exhibited significant growth during the period under review. The results show that time variable was significant in influencing rice production, rice imports and rice consumption all at 1%. This is because, the coefficient of the time variable was positively signed and statistically significant at 1% with respect to quantity of rice production, quantity imported and quantity consumed of rice indicating a general increase in yield of rice, quantity imported and quantity consumed of rice in Nigeria within the period under review. This implies that quantity of rice production, import and consumption in Nigeria within the period under study depended on time trend variable. Table 1 shows further that the coefficient of multiple determination is high (R^2=0.877 for rice production; 0.625 for rice imports and 0.920 for rice consumption) and significant ($p<0.01$). This implies that87.7%, 62.5% and 92.0% of the total variations in rice production, rice imports and rice consumption was due to time trend variable. This also implies that growth in rice production, imports and consumption is highly time dependent.

The F –ratio is statistically significant at 1% alpha level which implies the model gives a good fit, has a sound explanatory power, confirmed the overall significance of the regression (trend) model and as such can be used for forecasting purposes.

Compound Rate of Growth of Rice Production and Imports in Nigeria (1970-2016)
The computed compound rates of growth in quantity produced, imported and consumed of rice in Nigeria within the study period are presented in table 2.

Table 2 Compound growth rate for quantity of rice produced, quantity imported of rice and quantity of rice consumed

Variables	Parameter (β1)	Exponential compound Growth rates (%)
Quantity of rice produced	0.054	5.55
Quantity of rice imported	0.116	12.30
Quantity of rice consumed	0.062	6.40

Source: Calculated from the Estimated Exponential Trend Equations in Table 1

The annual compound growth rate in rice production, imports and consumption in Nigeria over the study period were 5.55%, 12.30% and 6.40% respectively. This finding is in line with Ojoehemon *et al.,* (2009), who noted that both rice production and consumptions have vastly increased with rice demand outstripping rice production thus spurring rice importation. The 6.4%per annum rice consumption growth rate estimate in this study is closely related to the 7% per annum used to make a projection of rice demand of 35 million tons in 2050 (Ayanwale and Amusan, 2012). The result of this study indicates that the rice demand-supply gap scenario have been an existing trend that would continue if appropriate measures are not taken to salvage the situation. The compound growth rate in the quantity imported of rice in Nigeria was fastest (12.30% per annum) while the compound growth rate in the quantity produced of rice in Nigeria was slowest with a compound growth rate of 5.55% per annum. As noted by Bamba *et al.,* (2010), the cost of rice imports represents a significant amount of lost earnings for the country in terms of jobs and income.

Acceleration, Deceleration or Stagnation in Quantity Produced and Imported Of Rice (1970-2016)

Table 3 shows the results of the quadratic equation in time variables fitted for quantity produced of rice, quantity imported of rice and quantity consumed of rice

Dependent Variable	β_0	β_1	β_2	R^2	F-ratio
Quantity of rice produced	5.427 (65.223)***	0.107 (12.824)***	-0.001 (-6.647)***	0.939	337.090***
Quantity of rice imported	2.013 (4.847)	0.294 (6.519)***	-0.004 (-4.092)***	0.728	58.888***
Quantity of rice consumed	5.677 (78.319)***	0.114 (15.683)***	-0.011 (-7.361)***	0.964	591.758***

Source: Computed from time-series data, 1970-2016 Note: *** = significant at 1% alpha level. Figures in brackets are t-values.

To investigate for the existence of acceleration or deceleration or stagnation in growth of rice production, import and consumption, the quadratic equation in the time trend variable were fitted according to the equation. Results in Tables 3 show that the statistically significant negative value of the coefficient of time variable (β_2) for quantity of rice produce, imported and consumed revealed deceleration in the growth rates of this variable, thus, indicating that quantity of rice produced, imported and consumed in Nigeria increased at a decreasing rate during the entire period (1970 -2016). This conforms to the findings of Tanko *et.al* (2010) who observed a deceleration in production and productivity of rice for the period 1985-2006 but not in tandem with those of Ibrahim *et.al*. (2010) who realized accelerated growth in rice for the period 1983-2003 and Onyenweaku (2004) who discovered a stagnated growth in the Nigerian agricultural production for the period 1970-2000.

Conclusion and Recommendations

Quantity of rice production, quantity imported and quantity consumed in Nigeria all exhibited significant deceleration in growth during the period under review. The time variable was significant in influencing rice production, rice imports and rice consumption and the annual instantaneous rates of growth in quantity of rice production, import and consumption in Nigeria within the period under study were 5.4%, 11.6% and 6.2% respectively while their annual compound rates of growth within the same study periods were 5.55%, 12.30% and 6.40% respectively. The study recommends that the process of deceleration in rice production should be revised by intensifying research in order to improve rice production technologies significantly in a way that the rate of growth will achieve the needed self- sufficiency in domestic rice production and thereby reducing the amount of money spent in rice imports in this country. Also, rice production needs to be stepped up through the implementation of output scheme policies that would help boost the growth of domestic rice production. Technological research on early maturing, easy soil acclimatization and disease resistant rice seedling will have a multiplier effect on domestic rice production and thereby reduce rice importation in Nigeria. Effort should be made to grow rice production level geometrically to maintain pace with population growth if food security is to be ensured in Nigeria. This can be pursued through adequate and timely financing of rice production activities.

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Consequences of Oil and Gas Exploration and Extraction in Nigeria: An Awareness of the Impacts on Food Security and Livelihoods in Oil Producing Rural Communities

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Abstract
This stud□□□□□□carried out in the Niger Delta region of Southern Nigeria where the bulk of Nigeria's crude oil is being extracted. The study employed both qualitative and quantitative perspectives in accessing people's awareness of the consequences of crude oil exploration and extraction in oil producing rural communities. The qualitative aspect of the study involved the focus group discussion consisting a total of 31 participants, while the quantitative aspect involved a questionnaire survey on 446 respondents. The result indicates that only a negligible percentage (9.7%) of the focus group participants indicated awareness of the oil and gas industry's support for agricultural development in rural communities. On the other hand, an overwhelming majority (100%) of the participants indicated awareness of pollution and pipeline explosion among the major negative consequences of the oil and gas industry. Other negative effects of the industry indicated include; food safety issues (74.2%), damage to forest resources (87.1%), loss of farmlands (83.9%), low of crop yield (77.4%), social crisis (90.3%) and high cost of living (93.5%). The ordered probit results indicate that with a P-value of 0.01, farmers more than fishermen and those in other occupational groups, perceived that the oil and gas industry affects agriculture in oil producing areas. Also, with P-value of 0.01, fishermen more than other occupational groups indicated that the industry has very high impact on water resources. These suggest that rural farmers and fishermen are comparatively more vulnerable to the negative consequences of oil and gas exploration and extraction in the region. By inference, oil and gas operations affect human livelihoods and food security in oil producing areas in Nigeria. Thus, the study recommends that oil and gas companies should improve on their support for agricultural development in the rural areas by sponsoring trainings of rural farmers, support for extension services, and funding for research in agriculture among others.

Keywords: *Crude oil, rural communities, agriculture, oil and gas industry, Niger Delta, Nigeria.*

Introduction
Human livelihood depends largely on the natural environment, thus the health condition of the environment determines to a large extent, the quality and efficiency of ecosystem services. In oil and gas producing areas, the ecosystem suffers persistent distortions that affect the biological and physical nomenclature and potential of environmental resources. These changes affect human livelihood (Ukpong *et al*., 2017). In other words, the oil and gas (O&G) industry comes with a cost to the natural environment and human livelihood (Bhau & Ukpong, 2018). One of the major costs comes from oil spills and facility explosions which result in pollution that affects ecosystem services and environmental resources including land, air, forest and water resources (Ukpong *et al*., 2017). Pollution from the O&G industry includes mainly; land pollution, air pollution and water pollution. Air pollution is one of the inherent risks of O&G extraction, mostly triggered by gas flaring, and Nigeria flares more gas than any other country in the world (Emoyan *et al.,* 2008). Gas flaring is a routine practice by the O&G industry where 'excess gas' is being flared into the environment under a supposedly controlled medium, to relieve dangerous equipment overpressure conditions. However, gas flaring contributes to climate change and global warming,

and remains one of the major sources of air pollution (ERA, 2005; Kan *et al.,* 2012, Zhang *et al.,* 2012). Land pollution affects the fertility and productivity of the land, hence affecting the volume and quality of crop yields (Pegg & Zabbey, 2013). This might contribute to high food prices, food safety issues and food insecurity. Food safety is a global issue and millions of people across the globe are reported to have either died or fallen ill as a result of consuming unsafe food (Ordinioha & Brisibe, 2013). Evidently, the O&G industry has both direct and indirect consequences on agriculture and food safety, result from a range of activities involving crude oil (oil and gas) exploration and extraction. These activities affect farmlands, for instance, a large mass of land can be occupied by oil and gas facilities such as pipelines. Also, crop yield is often affected especially in the event of an oil spill resulting in soil pollution (Ekpebu & Ukpong, 2013). This affects the quality of food crops, resulting in poor yields or outputs, hence high food prices, which affect the quantity of food available in the markets and accessible to rural households. Under such conditions, poor households are not able to afford the high-cost food, resulting in food insecurity and hunger. In other words, the processes of crude oil exploration and extraction affect food security in oil producing areas. It is therefore important that the industry's social responsibilities should be more focused on these issues, especially to promote agricultural production to enhance food security and affordable food prices in the rural markets.

The O&G industry also affects water resources, causing contamination of valuable aquatic organisms, including fish and other seafood, especially during crude oil spills (Cunha *et al.,* 2014). Besides the effects on air, land and water resources, the activities of the O&G industry during exploration and extraction of crude oil, have direct impacts on the forests on which most of the rural population also depend for their food and means of livelihood. The forest is an integral part of the natural environment which offers essential ecosystem services, and remains a critical economic resource in the rural areas serving as a major source of livelihood for rural people in terms of provision of food, income and employment (Mmom & Arokoyu, 2010). However, there is high concern over forest degradation (forest clearance) in recent years as a result of O&G exploration and extraction (James *et al*., 2007; Kuenzer *et al*., 2014). In particular, crude oil pollution poses a hindrance to ecological performance and resilience of the environment, and the impacts of oil pollution on the forest and other ecological resources, mainly as a result of oil spills and facility explosions have also raised global concerns (Giri *et al.,* 2011; Hong *et al.,* 2014). In view of this background, this study seeks to; assess awareness of the consequences of crude oil exploration and extraction in oil producing rural communities in Nigeria, determine the influence of socioeconomic characteristics on people's perception of the consequences of crude oil exploration and extraction in oil producing rural communities in Nigeria and make suggestions and recommendations based on findings of the study.

Materials and Methods

The study was carried out in selected oil producing rural communities in the Niger Delta region of Southern Nigeria, where majority of the rural population depend largely on agriculture and the natural environmental resources. The region is made up of a large terrain of mangrove forest supported by rivers and rivulets, and the coastal linings of the Atlantic Ocean, with high economic value for the rural community (Kuenzer *et al*., 2014).

Both qualitative and quantitative data were used for the study to access people's awareness of the consequences of crude oil exploration and extraction in oil producing rural communities in Nigeria. The qualitative data were collected through three focus group sessions involving thirty one (31) participants. The quantitative data were collected through the use of survey questionnaires administered to 446 respondents, selected from fifteen (15) communities in the region. The study also involved site visits carried out within the study area to observe and obtain pictorial data related to the subject matter.

Results and Discussion

Results of the analyzed FGD are presented in Table 1. From this result, the participants identified seven major positive impacts of the O&G industry in the Niger Delta. The result shows that the majority (74.2%) of the participants identified provisions of employment by the industry. Over 58% mentioned provision of borehole water, and support for skills acquisition, with as low as 12.9% and 16.1% indicating awareness of provision of road construction and electricity.

Participants' knowledge of the industry's support for agriculture was comparatively negligible, with only 9.7% of the participants indicating awareness. The result suggests that the majority of the respondents may not have been aware of the industry's contribution to agriculture or support to farmers, yet agriculture is among the economic activities mostly affected by crude oil exploration and extraction in the region. The comparatively low percentage of awareness suggests that the supposed industry's support for agricultural development may not have been widely distributed. Improved support for skill acquisition would help create employment, hence helping to address insecurity and socioeconomic issues. On the whole, the varying proportions of awareness suggest that most of these benefits are either not adequately provided or not widely spread across various communities.

Table 1 Summary of Focus group participants' Awareness of Positive Impacts of the O&G Industry in the rural communities in the Niger Delta region

S/N	Positive contributions	Percentage of Respondents
1	Agriculture support	9.7
2	Skill acquisition	58.1
3	Road construction	12.9
4	Scholarship	48.4
5	Boreholes	58.1
6	Electricity	16.1
7	Employment	74.2

Note: Multiple responses recorded

The results in Table 2 indicate high percentage of awareness of high impacts on farmland (83.9%), and low crop yield (77.4%) suggesting that agriculture in the region has been seriously affected. As much as 77.4% of the respondents indicated awareness of the impacts of the industry on crop yield.. Oil pollution affects soil fertility and crop yield which is a direct threat to food security. In communities such as rural oil producing communities in the Niger Delta where most people depend largely on farming, persistent negative impacts on crop yield can result in severe cases of hunger and poverty. Samy *et al*. (2015) reported that most people in the Niger Delta depend largely on farmlands for their livelihood. As also shared by Evangelou *et al. (*2015), pollution from oil spills have a statistically significant effect (negative impacts) on crop yield' in oil producing areas. Other areas of livelihood that are negatively affected include: Water resources (74.2%), forest resources (87.1%) and high food prices (93.5%). Access to affordable food and price stability can contribute to equity and poverty alleviation by helping to reduce the vulnerability of poor people to changes in food prices (Timmer, 2000). Food price fluctuation can reduce economic growth with implications for the living standards of rural households (Myers, 2006). Food price is therefore a critical issue in addressing socioeconomic problems in the region.

Table 2: Summary of Focus group participants' awareness of the negative impacts of the O&G industry in the Niger Delta

S/N	Negative issues	Percentage of respondents
1	Acid rain	22.6
2	Gas flaring	83.5
3	High cost of living	93.5
4	Social crisis	90.3
5	Moral degeneration	41.9
6	Pipeline explosion	100
7	Damage to water sources	74.2
8	Loss of farmland	83.9
9	Low crop yield	77.4
10	Loss of forest resources	87.1
11	Food safety issues	74.2
12	Roof top corrosion	51.6
13	Pollution	100

Multiple responses recorded

An ordered probit regression analysis was carried out to assess the influence of socioeconomic characteristics on people's rating of the consequences of O&G exploration and extraction. The levels of consequences were designated as levels of impacts labelled as follows: no impact, low impact, moderate impact, high impact, and very high impact. The results are presented in Tables 3 below.

Table 3: Ordered Probit estimates of people's awareness of the negative impact of O&G exploration and extraction

Variable	Negative impact on water resources	Negative impact on Agriculture
	Coefficient (S.E)	Coefficient (S.E)
Educational level	0.091 (0.090)	0.0541 (0.080)
Family size	-0.021 (0.041)	0.032 (0.036)
Age	0.025** (0.010)	-0.006* (0.009)
Income	-3.7E-6* (4E-6)	-1.6E-6* (3.4E-6)
Gender = Female	0.095 (0.144)	0.082 (0.127)
Marital Status		
Single	0.380 (0.340)	-0.151 (0.330)
Married	0.512*** (0.289)	0.050*** (0.284)
Occupation		
Farming	-4.644* (0.358)	0.996* (0.579)
Civil servant	-5.186* (0.312)	-0.987*** (0.468)
Oil company workers	-5.408* (0.340)	-2.059* (0.483)
Other company worker	-5.962* (0.300)	-1.297* (0.488)
Self employed (Business)	-5.383* (0.254)	-0.990** (0.438)
Unemployed	-5.263** (0.259)	-0.566 (0.475)
Student	-5.716* (0.000)	1.018** (0.477)
Likelihood Index (*P*)	0.000	0.000
Pseudo R^2		
Cox & Snell	0.117	0.209
Nagelkerke	0.154	0.237
McFadden	0.087	0.110
Number of observations	446	446

Figures in parenthesis are standard errors (S.E). The variable 'fishing' is a reference variable in the model.

The results indicate the significance of model coefficients at various levels including age, income, marital status and occupation. The significance of the Age coefficient at p=0.05 confidence level suggests that older people more than young people might be comparatively more concern about water resources. On the other hand, the coefficient of Age at p=0.01 confidence level indicates that young people's are comparatively more concern about the negative impact of the O&G exploration and extraction on agriculture. The result suggests that there might be comparatively more young people engaged in agricultural activities in the area, while there might be comparatively more older people engaged in water related activities such as fishing. Thus, a reduction in the negative impacts of the O&G industry would enhance agricultural development, and allow for gainful fishing, thus helping to improve the livelihood of both young and old people in the area. The significance of income variable suggests that people with comparatively low income are more concerned and perhaps more affected by the effects of O&G exploration and extraction on agriculture and water resources. The significance of the coefficient of marital status indicates that married people more than single people viewed the impact of O&G exploration and extraction as very high, thus suggesting that married people might be more worried about the impacts compared to single people. This might confirm comparatively high dependency of married households on agriculture and water resources which are the main sources of livelihood in those areas.

Conclusion and Recommendations

Owing to the wide dependence of rural population on natural resources, the growing negative impacts of oil exploration and extraction remain a serious threat to people's livelihood and survival in oil producing areas. In particular, the Niger Delta region as an agrarian society is characterized by farmers who engage in crop and animal production, as well as those engaged in various off-farm activities including sales and marketing of agricultural products. Hence, mitigation of negative consequences of the O&G industry would promote improved livelihood, food safety and household income in oil producing rural communities in the region. Among the major findings of this study is that rural farmers and fishermen are more vulnerable to the negative consequences of oil and gas exploration and extraction. Again, poor support for agricultural development by oil and gas firms impact negatively on the rural people in the study area. Based on these findings, it is recommended that oil and gas companies should improve on their support for agricultural development in oil producing rural communities by sponsoring trainings of rural farmers, support for extension services and provide adequate funding for research in agriculture and improved fisheries technology.

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Socio Economic Variables of Coffee Traders in Kogi State, Nigeria

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Abstract
The study assessed the market level characteristic factors influencing coffee marketing in Kogi State. Three towns within Ijumu Local Government Area (Iyamoye, Kabba and Ilogun-bunu) were purposively sampled. These areas are known for the cultivation, production and marketing of this crop. Twenty eight traders (farmers) were randomly sampled from each of the towns. A total sampling frame of eighty four respondents was used. Structured interview schedules were used for data collection from respondents. Data were analyzed using descriptive statistics (frequency and percentages). Farm size, variety of coffee, marketing channel, trading experience, membership of association, price satisfaction and selling method constituted major socio economic variables influencing coffee marketing in the study area.
Key Words: Coffee, Marketing, Cobb Douglas, Variety, Policies

Introduction
The vast majority of coffee production has its roots in colonialism, during which missionaries or colonialists usually imported the plant. Coffee then became a "cash crop, planted and harvested by serfs or wage laborers on large plantations, then exported to imperial countries" (James, 2000). Consequently, governments, ethnic relations and general ways of life were changed in these countries because of the shift to the new reliance on coffee production. However, with the growth of the United States economy, the market for exporting coffee also expanded. Therefore, coffee became a major source of income for many countries in Central and South America, Africa, and South Asia where colonialism was present and the environment was ideal for coffee trees (Cleland, 2010). Meanwhile, the coffee plant originated in Ethiopia. However, coffee-drinking habits had spread to Europe by the 17th century.
According to Milford (2004) the coffee tree can be grown only in warm areas without frost or sudden temperature shifts, and it also needs plenty of rain. This explains why it is a common export commodity for countries in tropical areas, and an unsuitable one for the rest of the world. Commercially grown varieties are *Coffee Arabica* and *Coffee Robusta*. *C. Arabica* has a mild taste, it is more fragile, and its best growing conditions are found in warm zones or in the highlands of tropical zones. Contrastingly, *C. Robusta* is more resistant and can be grown between sea level and 800 metres above sea level (Milford, 2004).

However, the producers of these coffee beans are often small-scale farmers who are reliant on faceless consumers, large corporations and an ebbing market for their income and resources. Meanwhile, empirical studies reveal that smallholders in developing countries face numerous constraints due to the pervasive imperfections of markets. Increasing evidence shows that through collective action smallholders can reduce transaction costs of accessing input and output markets, adopt efficiency-increasing and value-adding technologies, and tap into high-value markets associated with certification and labeling (Kersting and Wollni, 2012; Wollni and Zeller, 2007; Gruere *et al.,* 2009; Devaux *et al*., 2009; Narrod *et al*., 2009). In the early 2000s, a historic world market price slump hit millions of coffee farmers hard, especially smallholder producers in Africa and Latin America (Ponte, 2002). The volatility of coffee markets in combination with poor production infrastructure and services have sunk the majority of coffee producers in developing countries in low-input-low-output cycles and structural poverty. Similarly, coffee is a traditionally worldwide traded cash crop with new emerging markets; many coffee-producing developing countries such as Nigeria are struggling with production and marketing of the crop (Jena *et al*., 2012). In addition, smallholder coffee growers face high transaction cost, lack of market information, poor infrastructure, and weak capital markets (Anteneh, *et al.,* 2011**)**. Moreover, imperfect competition in which farmers are getting paid less for their produce than they would in a competitive situation occurs among the smallholder coffee growers in Nigeria. This loss of income may have a serious effect on the life situation of a trader who is living close to absolute poverty. When this effect is added to the other aforementioned factors that are characteristic of the coffee industry, we can perhaps understand why many of these farmers see this situation to be unfair. The objective of the study was to profile the socio economic characteristics of the coffee traders in the study area.

Methodology

The study was conducted in Kogi State, Nigeria. The state is in the middle belt region and falls in to the guinea savannah agro ecological zone of the country. Three towns within Ijumu Local Government Area (Iyamoye, Kabba and Ilogun-bunu) were purposively sampled. These areas are known for the cultivation, production and marketing of this crop. Twenty eight traders (farmers) were randomly sampled from each of the towns. A total sampling frame of eighty four respondents was used. Structured interview schedules were used for data collection from respondents. Data were collected on socio economic characteristics such as age, educational status, marital status, gender and membership of farmers' group, respectively. Additional information was gathered through informal discussions with the farmers and by personal observations of the crop in some of the farmers' fields. Data were analyzed using descriptive statistics frequency, percentages and mean.

Results and Discussion

Table 1 shows the socio-economic characteristics of Coffee farmers/traders. The table reveals that all the farmers (100%) were men.

Table 1: Socio economic characteristics of Coffee Farmers in Kogi State

Variables	Frequency	Percentage (%)	Mean
Sex			
Male	84	100.00	
Female	00	00.00	
Total	84	**100.00**	
Age (Years)			**64**
50-59	20	24.00	
60-69	32	38.00	
70 and Above	32	38.00	
Total	84	**100.00**	
Marital Status			
Married	76	90.00	
Widowed	8	10.00	
Total	84	**100.00**	
Education (No of years)			**2**
No Education	52	60.00	
Primary	8	10.00	
Secondary	8	10.00	
Tertiary	16	20.00	
Total	**84**	**100.00**	
Membership of Farmers'Group			
Yes	64	76.00	
No	20	24.00	
Total	**84**	**100.00**	
Household Size (No. of Persons)			**8**
1-5	20	24.00	
6-10	44	52.00	
Above 10	20	24.00	
Total	**84**	**100.00**	
Farm Size (Hectares)			**5**
1-5	40	48.00	
6-10	44	52.00	
Total	**84**	**100.00**	
Trading Experience (Years)			**29**
10-29	44	52.00	
30-49	36	43.00	
Above 50	4	5.00	
Total	**84**	**100.00**	
Marketing Channel			
Local Buying Agents	68	81.00	
Exporters	16	19.00	
Total	**84**	**100.00**	
Coffee Variety			
C. Arabica	20	24.00	
C. Robusta	64	76.00	
Total	**84**	**100.00**	

Source: Field Survey, 2016

This result is in conformity with Adinoyi and Attanda (2016) who reported that majority (94.4%) of groundnut farmers are male. Similarly, Girei *et al* (2013) reported that in Africa, men are more in a crop that is perceived to have commercial value. The implication of this is that coffee trading in the study area is largely dominated by male gender. Moreover, the mean age of the traders is 64 years. The implication of this is that coffee traders in the state are ageing and almost out of their productive years and this perhaps may be responsible for the average farm size (5ha) put into cultivation of the crop by farmers in the study area. Similarly, the table reveals that about 60% of the farmers had no access to former education with average years of educational level being about 2 years. The implication of this is that the farmers may perhaps not have access to market information system (MIS) with respect to both production and marketing of the crop. Furthermore, the table reveals an average household size of 8 persons. This is in conformity with the result of Ibitoye *et al* (2012). They reported an average household size of 8 persons in their study on the socio economic variables of and their profitability levels in maize production in Kogi State. This implies that the farmers may perhaps utilize members of the household as labour for some operations relating to production and marketing of the crop. This may reduce some transaction costs that may be incurred on the crop. Mean trading experience was about 29 years. This means that the farmers have adequate knowledge of marketing the crop. This perhaps may influence the choice of marketing channels as the farmers sell to preferred buyers.

Conclusion

The study assessed the socio economic variables of coffee traders in Kogi State. Farm size, variety of coffee, marketing channel, trading experience, membership of association, price satisfaction and selling method constituted the socio economic characteristic factors influencing coffee marketing in the study area. More efforts should be made to assess variety of coffee that is more preferred by the buyers. In addition, farmers should be trained on the variety of the crop that has higher market demand with a view to increasing its production in the study area. Similarly, farmers should be given incentives to increase their farm holdings for higher productivity. In addition, there is need to maintain or improve on the price satisfaction existing between the farmers and the buyers of the commodity to avoid imperfect market in the study area. Farmers that are members of association should be encouraged to improve on their participation as this will go a long way in price determination for increased profit. This will encourage and improve coffee traders' access to market information and as such will be able to sell the crop for more profits.

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Influence of credit accessibility on households' food security among Farmers in South-Western Nigeria

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Abstract
Food security and factors influencing it have been topics of interest in developing countries in recent years. This study is coming to further reiterate the importance of credit facilities on food security by investigation the nexus that exists between the two. The study used multistage random sampling technique to select 161 households from the nine selected local government areas from Osun and Oyo states in South Western Nigeria. Primary data collected with the aid of structured questionnaires were used for the study. The findings of this study revealed that majority (53.4%) of the households investigated had access to one or more forms of credit facilities to meet the dietary needs of their members and also utilize the accessed credit facilities principally on direct consumption in their respective households. The findings also indicated that households with access to credit facilities constituted majority of food secure households in the study area thereby underscoring the key role access to credit plays on food security at household level. The findings of the study implied that much could be achieved in achieving the zero hunger targets as being envisaged by SDGs by 2030 if credit facilities are made available for agricultural production and business enterprises to guarantee sustainable income for households to meet their dietary needs.
***Key words**: Food security, credit, household, farmers*

Introduction
Food insecurity is currently considered as a development challenge in the world particularly in developing countries including Nigeria where food production is not commensurable with the prevailing growth rate in the affected countries (Fawole and Ozkan, 2018). Food insecurity has been attributed to many factors such as low income, population growth, livelihoods and access to productive factors of production such as credit facilities among other things (Babatunde *et al.* 2007a). Agriculture is undoubtedly the largest components of the rural economy in Nigeria and most sub-Sahara African countries (Ogundari, 2017). Among all the known factors that have contributed to food insecurity in Nigeria lately, decreasing fortunes of agricultural production has taken the lead (Fawole *et al*. 2016). The decreasing fortune of agriculture has been aided principally by lack of access to credit facilities by smallholder farmers who constitute the bulk of food producers in developing countries (Fawole and Ozkan, 2018). FAO (2002) defined food security as "availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices". Africa has not been able to feed herself since 1970s and may be unable to do so soon and this is the greatest reality that stakeholders in the food sub-sector in sub-Sahara Africa often sigh away from but it is real (Martin, 2004). Similarly, Wu *et al*. (2011) posited that African countries may face decline in per capital food availability in coming years a position that has not been countered by superior policy actions. In many or most African countries, food security at both national and household levels is still not encouraging. The per capita growth rate in food production in some of these countries is still far lesser than corresponding growth in population which is not enough to meet the rising demand for food at household level leaving many undernourished thus creating an embarrassing gap between food supply and demand. For instance, the Nigerian population annual growth rate is around 3.5 percent with accompanying 2.7 percent growth rate or less in agriculture which is largely insufficient to meet food needs of the entire population (Ogundari, 2013). Before

now, agriculture especially food production used to be an important sector of the Nigerian economy because of its significant contribution to national economic growth. As of 2000, it constituted 30% of the annual GDP, 70% of the labour force, 70% of the non-oil exports and 80% of the food requirements of the nation (Adegboye, 2004). Of the Nigerian total GDP, as of 2014 according to the Central Bank of Nigeria (CBN) data as obtained, agriculture constitutes 20.24 percent; of this percentage crop production constitutes 87.76 percent, livestock 8.73 percent, forestry 1.15 percent and fishing 2.36 percent (CBN, 2014).

From the above illustrations, it is evident that any factor that affects the fortunes of agriculture on one hand would definitely affect food security situation on the other hand. Therefore, this study was carried out to investigate the nexus that exists between food security in households and the accessibility of households to credit facilities either to support their food production or other business enterprise that would thereafter improve the income of the household to meet their dietary needs.

Materials and Methods

This study was conducted in the South-Western Nigeria. Primary data collected from 161 households with the aid of structured questionnaires were used for this study. Similarly, multistage sampling technique involving four stages was used to select the households for the study (Iorlamen et al. 2013). The first stage involved purposive selection of two states (Osun and Oyo) followed by the second stage which involved selection of four and five local governments from the two states respectively based on their population. The third stage of the sampling was the random selection of towns and villages from the selected local governments and last stage was the random sampling of at least 15 households from each of the selected local governments in the two states. The data were analyzed using both descriptive statistics and inferential analysis as collected from the survey as explained earlier while the prevailing food security at respective households were based on total calorie consumption with minimum per capita calorie consumption pegged at 2300kcal/day/AE (Amaza et al. 2008). Households whose calorie consumption was above the minimum were categorized as food secure while those with lower than minimum were food insecure. This procedure was carried out for households with and without access to credit facilities.

Results and Discussions

The findings of this study as shown on Table 1 revealed that majority (53.4%) of the households investigated had access to one or more forms of credit facilities to meet the dietary needs of their members. Conversely, the remaining (46.6%) had no access to any form of credit facilities thus relying solely on their income to meet their dietary needs. Furthermore, majority of the sampled households were food secure based on the quantity of calories consumed in those households. In other words, majority of the households consumed above the minimum recommended daily allowance of 2300kcal/day/AE. Majority (63.6%) of the food secure households were those with accessibility to one or more forms of credit facilities. However, food insecure households were majorly accounted for by those without access to any form of credit facilities.

Table 1: Distribution of households according to food security and credit accessibility

Credit access/Food security	Food secure	Food insecure	Total
With credit access	56	30	86
Without credit access	32	43	75
Total	**88**	**73**	**161**

Source: Field survey, 2017

Furthermore, the findings of the analysis of the food data as presented on Table 2 showed that strong and positive correlation exists between credit accessibility and food security among households in the study area.

Table 2: Correlation between food security and access to credit among households

		Food security	Access to credit
Food security	Pearson Correlation	1	0.690**
	Sig. (2 – tailed)	-	0.05
	N	**161**	**161**
Access to credit	Pearson Correlation	0.690**	1
	Sig. (2 – tailed)	0.05	-
	N	**161**	**161**

** Correlation significant at the $p < 0.05$ (2 – tailed)

The findings based on the utilization of accessed credit are presented on Table 3 indicated that majority of the households utilized their credit on direct households' consumption including foods and this accounted for 41% of the entire households while some expended the credit facilities on agricultural production to provide food and sometimes income to meet other needs of their households some expended the credit of other business enterprises to generate income that were in turn utilized to procure foods of their choice to meet the dietary needs.

Table 3: Distribution of households according to credit utilization

Utilization	Number of households	Percentage
Agricultural production	40	24.8
Direct consumption	66	41.0
Business enterprises	45	28.0
Others	10	6.2
Total	**161**	**100**

Source: Field survey, 2017

Similarly, majority of the investigated households relied on cooperative societies to which they belonged to access credit facilities based on the findings as presented on Table 4 subsequently. Therefore, these findings implied that food security in the households increased with accessibility to credit facilities.

Table 4: Distribution of households according to sources of credit

Credit source	Number of households
Bank	52
Cooperatives	71
Government	34
Relatives	41
Money lender	25

Source: Field survey, 2017; Note: Some households accessed credit from more than one source

Finally, these findings as outlined above are in congruent with Muche et al. (2014), Obayelu (2012) but are however in contrast with those of Babatunde et al. (2007b).

Conclusion

The findings of these studies have shown that for the attainment of food security in the country as a whole, credit accessibility will play a key role. This is so because when food security in households with and without access to credit facilities was compared, it was clear that those households with access to credit facilities showed high rate of food security. Therefore, for Nigeria to achieve zero hunger as being envisaged by SDGs in 2030 the stakeholders must ensure unhindered access to credit facilities for citizens particularly to those engaged in food production and businesses in such a way that even when the households are not engaged in direct food production to meet the dietary needs of their respective households they could be provided with credit facilities to enable them engage in other activities such as small and medium scale enterprises that could enable them garnet resources that would enable them acquire their needed food items from the market. The import of this study is to sensitize the concerned stakeholders on the importance of credit on achievement of food security in the country particularly through indirect intervention to agriculture to stimulate indirectly food availability and access among households in the country with a view to achieving a completely food secure nation.

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Coping Strategies and Determinants of Food Insecurity among Farm Households in Isiala Ngwa North Local Government Area of Abia State, Nigeria

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Abstract
This study identified coping strategies and determinants of food insecurity among farm households in Isiala Ngwa North Local Government Area of Abia State, Nigeria. Multistage random sampling technique was employed in collecting data from 90 farm households using semi structured questionnaire. Data were analyzed using descriptive statistics, food security index, and Probit regression model. Result showed that 59% of the farm households were food insecure. Various strategies such as eating less expensive food (73.58%), and allowing children to eat first (69.81%) were adopted by the farm households to cope with food insecurity. Probit regression result showed that gender, household size, non-farm income activity, educational level, membership of cooperatives, extension access and farm income were significant determinants of farm households' food insecurity status. There is need to boost income generating potential of food insecure farm households. To this end, heads of farm households should be trained by relevant agencies on improved farming technologies and skill acquisition so as to boost their farm and non-farm income earning capacity and subsequently reduce household food insecurity.
Key words: *Coping strategies, farm households, food insecurity*

Introduction
Food security and insecurity are terms used to describe whether or not individuals, households or an entire nation have access or not to sufficient quality and quantity of food (Osei *et al.,* 2013). Food security is defined as a situation that exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life (FAO, 1996). Food insecurity on the other hand, is the inability of a household or individuals to meet the required consumption levels in the face of fluctuating production, price and income (Maharjan and Chhetri, 2006). A food insecure household has inadequate food available to it to ensure minimum intake for all members (usage) and does not have adequate capacity to effectively demand for more food if there is such need. Maintaining food security at the household level and individual level is still a major challenge for many developing countries including Nigeria. FAO (2012) estimated that about 900 million people globally are undernourished (food insecure). Vast majority of these undernourished people (about 852 million) live in developing countries, with the most vulnerable region being sub-Saharan Africa.

The average amount of food available per person per day in the region was 1,300 calories compared to the world wide average of 2,700 calories (FAO, 2012). Ayodeji (2010) asserted that the number of hungry people in Nigeria is over 53 million, which is about 33% of the country's total population of roughly 160 million. The Global Food Security Index (GFSI) of the Economist Intelligence Unit ranked Nigeria among countries with low food affordability, availability and quality (Ahmed *et al.,* 2015). These are matters of grave concern largely because Nigeria was self-sufficient in food production and was a net exporter of food to other regions of the world in the 1950s and 1960s. Although, successive Nigeria governments in an attempt to alleviate the food insecurity problem in the country have made efforts to achieve national food security through setting up of a number of agricultural development institutions, and special programmes and projects which include: the National Agricultural Development Fund, NADF (2002); National Special Programme on Food Security, NSPFS (2002); National Food Crisis Response program [NFCRP] and Food Security Thematic Group [FSTG] in 2009, an overwhelmingly large proportion of Nigerians are still food insecure (Abimbola and Kayode, 2013).

Among Nigerian households, rural farm households are the most vulnerable to food insecurity even though they produce the bulk of food eaten within the country. Most foods produced by farming households in Nigeria are consumed, or sold for cash only to be repurchased when household barns run short with supplies. This cyclic and unstable condition most times leaves affected farm households in a state of food insecurity (Emerole *et al.,* 2014). According to Osondu *et al.* (2014) Nigerian agriculture is characterized by numerous smallholder farmers using mostly crude tools and low level technology, which results to low productivity, output and farm income. This hampers ability of affected farm households to achieve the minimum requirement of food nutrition. In view of the foregoing this study intends to: profile food security status of farm households in the study area; identify coping strategies adapted by food insecure farm households in the study area; and identify determinants of food insecurity among farm households in the study area.

Methodology

The study was conducted in Isiala-Ngwa North Local Government Area (LGA) of Abia State. The LGA has an area of 283km^2 and a population of 153,734 persons (NPC, 2006). The LGA is bounded to the North by Umuahia South LGA, to the South by Isiala-Ngwa South LGA, to the West by Imo River and to the East by Ikot-Ekpene and Abak LGAs of Akwa Ibom state. The climate is essentially tropical humid with annual rainfall of 1500-2600mm distributed evenly throughout the wet season (April to October). Mixed cropping system is mainly practiced. Food crops such as cassava, yam, maize, and melon, and cash crops such as oil palm, plantain and banana are most widely cultivated crops in the LGA. Animals reared include poultry, goats, sheep and pigs.

Population for the study comprise of all farm households in the area. Multi-stage random sampling technique was adopted. First, six communities were randomly selected. Secondly, three villages were randomly selected from each of the selected six communities. Lastly, five farm households were randomly selected from list of farm households in each of the selected 18 villages. Thus, 90 farm households were selected for the study.

A pre-tested semi structured questionnaire was used to collect primary data from the selected farm households through survey involving household heads and their spouses. The pre-test helped to standardize the questions in structure, instructions and ease of flow of response. The questions thus addressed what they ought to address (validity) and gave consistent answers from the same respondents in a test retest trial (reliability). The survey was conducted on daily basis for a period of two weeks. Data were collected on amount of food/calories consumed (24 hours recall method), age of household head, gender of household head, household size, household resource endowment, farm size, off farm income activity, level of education of household head, credit access, membership of cooperative, extension access, farm income and food insecurity coping strategies.

Food security index was used to profile food security status of the farm households. Frequencies and percentages were used to identify coping strategies adapted by the farm households against food insecurity and Probit regression model was used to identify determinants of food insecurity among farm households.

Two objective methods of food security measurement have been widely used in most food security studies (Maxwell 1996; Babatunde *et al.,* 2007). One method is to estimate value of household consumption and purchases of food items over time. The other method is to undertake food consumption recall for individual members of a household or entire household and analyze each type of food mentioned for calorie content. This second method is more often used by Food and Agricultural Organization (FAO) in food security measurements. In this study, a 24 hour recall method was used. The food security line was FAO recommended daily per capita calorie intake of 2260kcal. From data collected, quantity of every food item consumed by the households in the 14 days period were estimated. The quantities were converted to gram and the calorie content was estimated by using the nutrient composition table of food commonly eaten in Nigeria. Per capita calorie intake was calculated by dividing estimated total household calorie intake by the household size after adjusting for adult equivalent using consumption factors for age-sex categories. To get the households average daily per capita calorie intake, the sum of the household's per capita calorie intake was divided by fourteen. A farm household whose average daily per capita calorie intake is up to 2260Kcal was regarded as food secure and those with per capita calorie intake below 2260Kcal were regarded as food insecure farm households. The food security index was computed thus:

$$Zi = \frac{Yi}{R} \ldots \quad (1)$$

Where:
Zi = Food security status of ith farm households which takes values 1 for food secure farm households or 0 for food insecure farm households;
Yi = Daily per capita calorie intake of ith farm household;
R = Recommended per capita daily calorie intake (2260 kcal).
Zi = 1 when Yi greater than or equal to R and Zi = 0 when Yi less than R

Additionally, the food insecurity gap, surplus index and headcount ratio of food security were calculated for the sampled farm households based on the food security line following Babatunde *et al.* (2007) approach. The food insecurity gap (FIG) measures extent to which food insecure households are food insecure and the surplus index (SI) the extent by which food secure farm households exceed the food insecurity line food and the headcount ratio (HCR) measures percentage of the population of farm households that are food insecure.

$$Food\ insecurity\ gap\ (FIG)\ = \frac{1}{M}\sum_{i=1}^{m} Gi \quad (2)$$

M = Number of food insecure farm households
Gi = Per capita calorie intake deficiency for ith farm household

$$Gi = (\frac{Yi-R}{R}) \ldots \quad (3)$$

$$Headcount\ index\ (HCR)\ = \frac{M}{N} \quad \ldots \quad (4)$$

N= Number of sampled farm households

Based on the household food security index (Zi), the Probit model was used to identify determinants of food insecurity among farm households. The implicit form of the model was expressed as: $Y = \Sigma\beta x + \varepsilon i$ (6)
Where
Y= Food security status (food secure households = 1, food insecure households = 0);
$\beta_1 - \beta_7$ = Unknown coefficients value of factors;
β_0 = Constant; X = Vector of explanatory variables;
εi = Error term

The independent/explanatory variables included in the model are:
X_1 = Age of household head (years)
X_2 = Gender of household head (male = 1, female = 0)
X_3 = Household size (number)
X_4 = Household asset endowment (Naira)
X_5= Household Farm size (hectare)
X_6 = Non- farm income (Naira)
X_7 = Level of education of household head (schooling years)
X_8 = Credit access (access =1; no access = 0)
X_9 = Membership of cooperatives (member = 1; not member = 0)
X_{10} = Extension access (Number of extension contacts)
X_{11} = Farm income (Naira).

Results and Discussion

Food Security Status of the Farm Households

The summary of the food security status of the farming households is presented in Table 1. It was observed that food insecurity incidence of the farm households was 0. 59. This implies that 59% of the farm households were food insecure because their per capita calorie intake fell short of the recommended daily per capita calorie consumption used as food security line. Table further shows that the average per capita calorie intake of the farm households in the area was 2165kcal.The food insecurity gap/surplus index which measures the extent of deviation from the food security line, show that the food insecure households fell short of the calorie requirement by 38%, while the food secure households exceeded the calorie requirement by 29%. Average household size was 6 persons, while it was 4 persons for food secure households and 7 persons for food insecure households. Babatunde *et al*. (2007) obtained a similar result with respect to food insecurity incidence and gap in North Central Nigeria.

Table 1: Distribution of the farm households based on food security status

Food Security Indices	Food Secure	Food Insecure	All
Number of households	37	53	90
Household size	4.28	7.44	5.86
Per capita daily calorie intake	2924	1406	2165
Food security index (Z)	1.29	0.62	0.96
HCR (head count ratio/ incidence of food insecurity)	0.41	0.59	-
Food insecurity gap (FIG)/Surplus index (SI)	0.29	0.38	-

Source: Field survey, 2017

Coping Strategies of the Farm Households against Food Insecurity

Coping strategies of the food insecure farm households against food insecurity is shown in Table 2. The table shows that 73.58% of the food insecure farm households ate less expensive food as strategy against food insecurity. This agrees with Kuwornu *et al.* (2013) finding that when households are faced with food shortage, the predominant strategy they adopt is to eat less preferred and less expensive food. Meanwhile, 69.81%, 64.15% and 56.60% of the farm households allowed children to eat first, reduced proportion of meal size and used savings to buy food respectively as coping strategies against food insecurity. More so, 45.28%, 37.73%, 30.19% and 26.41% of the households reduced number of meal time, borrowed money to buy food, consumed seed stocked for next planting season and bought food on credit respectively. Although the study area is endowed with natural forests and one would have expected households to resort to searching for wild fruit when faced with food shortage, it was one of the least practiced strategy by the farm households with only 11.32% of the farm households practicing it. According to United Nations (2002) food insecure households adapt a variety of coping mechanisms against food insecurity.

Table 2: Distribution of the farm households based on Coping strategies against food insecurity (n = 53)

Coping strategy	*Frequency	Percentage (%)
Allowing children to eat first	37	69.81
Eating less expensive food	39	73.58
Reduction of meal size	34	64.15
Using savings to buy food	30	56.60
Working in exchange for food	15	28.30
Reducing number of meal time	24	45.28
Consuming seed stocked for next planting season	16	30.19
Sending household members to eat elsewhere	13	24.53
Buying food on credit	14	26.41
Borrowing money to buy food	20	37.73
Sale of livestock	1	24.53
Selling personal belongings	11	20.75
Eating wild fruits	06	11.32

Source: Field survey, 2017
*Multiple responses recorded

Factors influencing Food Security of the Farm Households
The result of the probit regression is presented in Table 3. The model correctly predicted 73.6% of the variations in dependent variable and posted a significant goodness of fit chi-square value of 37.316. The table revealed that seven out of the eleven factors variedly determined food insecurity of the farm households.The coefficient of gender of household head was negative and significant at 5.0% alpha level. This implies that male headed farm households had lower probability of being food insecure. According to Nwachukwu *et al.* (2014) female heads of farm households in Abia State generally have fewer years of formal education, lower access to credit, extension services and land compared to male farm household heads and consequently, female headed farm households have higher probability of being food insecure. The coefficient of household size was observed to be positive and significant at 5.0% alpha level. This implies that increase in household size increased farm households' probability of being food insecure. All things being equal, increase in household size results to more people eating from the same resources; leading to reduction in food intake. The likely explanation for this is that increasing household size results to rising demand for food. This demand, however, when not matched with higher food supply from own production or purchase, ultimately lead to the household becoming food insecure. This result consolidates finding of Babatunde *et al.* (2007).

The coefficients of non- farm income activity and level of education were negative and significant at 1.0% alpha level, implying that increase in both variables decreased probability of the farm households being food insecure. Non-farm income generating activities help to diversify sources of farm households' livelihoods and reduce the risks of food shortage during periods of unexpected crop failures. Also, income from non-farm activities can be invested in agriculture to increase farm output, farm income and food availability at the household level. The negative impact of level of education on food insecurity could be due to the fact that years of formal education are a major factor in wage earning opportunities and determination in Nigeria where the higher the academic qualification, the higher the wage/salary (Olabisi and Olawamiwa, 2014). In addition, formal education improves human capacity and technical know-how which aids rate of adoption thus improving productivity level and farm income of such households. The result supports findings of Babatunde *et al.* (2007) and Ahmed *et al.* (2015) but differs from finding of Sulaiman *et al.* (2015).

Membership of farmers association had a negative coefficient and was significant at 5.0% alpha level, implying that membership to farmers' association decreased farm households' probability of being food insecure. According to Babatunde *et al.* (2007) access to cooperative loans by a farmer depends on membership to the association and such accessed credit are expected to boost household's income, own food production and food consumption. This result is consistent with findings of Babatunde *et al.* (2007); Arene and Anyaeji (2010); Kuwornu *et al.* (2013); and Ahmed *et al.* (2015) which revealed positive and significant relationship between membership to association and households' food security status. The coefficients of extension access and farm income were negative and significant at 5.0% alpha level, implying that the probability of the farm households being food insecure decreases with access to extension services and rising farm income. Access to extension services tends to enhance chances of a household having access to better production techniques, improved inputs, as well as other production incentives that positively affect farm production and thus household food security (Sulaiman *et al.*, 2015). Income generated from the farm can be used to finance investment opportunities and consumption of other food items not produced by the household, thus increasing the household's overall food intake and food security status. This finding compares favourably with result obtained by Ahmed *et al.* (2015) but contradicts findings by Ojeleye *et al.* (2014) that farm income had a significant positive effect on household food insecurity status.

Table 3: Probit regression estimates of factors influencing food security status of the farm households

Variable	Coefficient	Standard error	Z-statistic
Constant	-2.538***	0.680	-3.731
Age of household head	0.035	0.028	1.211
Gender of household head	-0.187**	0.078	-2.432
Household size	0.341**	0.153	2.227
Household resource endowment	-0.044	0.031	-1.432
Farm size	-1.064	0.718	-1.482
Non-farm income activity	-1.762***	0.650	-2.712
Level of education of household head	-2.015***	0.392	-5.140
Credit access	0.529	0.513	1.031
Membership of cooperatives	-0.022**	0.010	-2.154
Extension access	-1.625***	0.489	-3.321
Farm income	-1.356***	0.286	-4.744
Correctly predicted	73.6%		
Log likelihood	-54.427		
LR(Chi^2)	37.316		
Prob (Chi^2)	0.000		

Source: Field survey data, 2017
** And *** significant at 5.0% and 1.0% alpha levels respectively

Conclusion

The study showed that 59% of the farm households were food insecure. Various factors such as gender of household head, household size, non-farm income activity, educational level of household head, membership of cooperatives, extension access and farm income were significant determinants of farm households' food insecurity status. Coping mechanisms embarked upon by the food insecure farm households have short term effect. There is need to boost income generating potential of food insecure farm households. To this end, heads of farm households should be trained by relevant agencies on improved farming technologies and skill acquisition so as to boost their farm and non-farm income earning capacity. Male headed farm households had lower probability of being food insecure, thus, female headed farm households should be targeted more in future programmes aimed at reducing farm household food insecurity. Farm household heads should be encouraged to participate in cooperative societies in order to have improved access to productive resources such as seed input, information dissemination and credit facilities so as to enhance their productivity level which will invariably improve their household food security status. Policies that will make extension services accessible to heads of farm households will go a long way in improving household food security in the LGA. Enlightenment programmes on family planning should be directed at farm households, in order to educate them on benefit of having manageable household size.

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Economic Analysis of Banana Fruit Marketing in Ivo Local Government Area of Ebonyi State, Nigeria

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Abstract
Economic analysis of banana fruits marketing in Ivo Local Government Area of Ebonyi State, Nigeria was studied. Data were collected through structured questionnaire from 120 respondents (60 retailers and 60 wholesalers). The data was analyzed using percentages, gross margin analysis and multiple regression analysis. Majority of the retailers (66.6%) and wholesalers (71.7%) were within the ages of 31 -50 years, about 83.3% of retailers and wholesalers (79%) attended formal education,. majority of the retailers (58.3%) and wholesalers (65%) had household size of at least persons, Most of the retailers (75%) and wholesalers (65%) do not belong to any marketing association, majority of the retailers (81.7%) and wholesalers (93.3%) have had more than 5 years marketing experience, only 1.7% of retailers and wholesalers (9.2%) acquired capital from the bank. Banana marketing is a profitable enterprise in the study area. It gives a benefit cost ratio of 1.4 and 2.7 for retailers and wholesalers respectively. Age of the marketers, their education level, marketing experience, cost of transport and access to credit were the factors that significantly affect retail banana fruit marketing in the study area, while age of the marketers, their educational level, marketing experience, cost of transportation and membership of co-operative association were the factors that significantly affect wholesale banana marketing in the study area

Key words: *Economics, Banana, Marketing, Ivo, Area*

Introduction
Banana (*Musa* spp) is a major starchy staple in the sub-Saharan Africa, providing more than 25% of the carbohydrates and 10% of the daily calorie intake for more than 70 million people in the continent (IITA, 2000). Yields are highest in western Africa estimated at 26.4 tons per hectare and lowest in Central region where it is estimated at 5.5 tons per hectare. A greater percentage of banana fruit harvested is lost to spoilage and infestations on transit to consumers (Njoku and Nweke, 1996). In developing countries, where tropical weather and poorly developed infrastructure contribute to the problem, losses are sometimes of staggering proportions (Echebiri and Mejeha (2004). However, relative attention given to banana is focused on its production technology while little is done on its marketing. Obasi (2008) noted that serious inefficiencies characterized the operation of the marketing system in most developing countries as a result of so many socioeconomic, political and other constraints militating against marketing efficiency.

Banana marketing activity in Ivo LGA has been deficient of relevant quantitative and qualitative information. This has made it difficult for the government, research institutes, policy makers, individuals and marketers to obtain holistic, relevant and reliable marketing information to work with. Availability of information is essential for deciding measures to prevent post- harvest losses of the fruit. Such measures may have to be taken by the small farmers, the private traders, the cooperatives, handlers and transporters, wholesale and retail marketers etc (Lynam *et al*., 2002). . It is therefore against this background that this study was undertaken to determine the effect of socio-economic characteristics of marketers on their income and estimate costs and returns to banana friut marketing in the study area

Methodology

The study was carried out in Ivo Local Government Area of Ebonyi State, Nigeria. The area is located between latitude $5^0 56^1$ and $6^0 59^1$ North of Equator and longitude $7^0 35^1$ and $7^0 4^1$East of the Greenwich Meridian. Its rainfall ranges from 1500 -2500mm, temperature of 28-45^{0}c and moderate Relative Humidity of 75%. Ivo Local Government Area has an area of 350,659km^2 with population of 220,919 people (NPC, 2006). It comprises five (5) autonomous communities namely, Ishiagu, Ihie, Okue, Umuihe and Akaeze. Ivo people are mainly agrarians, prominently in the production of rice, plantain, banana, okra, yam, cassava, sweet potato, cocoyam and vegetables. Data was collected from respondents by the use of structured questionnaires and oral interview. Multi-stage random sampling procedure was used to select respondents for this study. This was done in the following stages; Stage1involved random selection of two (2) markets in the area. In stage 2, thirty (30) wholesalers and thirty (30) retailers were randomly selected from each of the two markets making a total of 120 respondents who formed the sample size for the study. Descriptive statistics (Tables and Percentages) was used to analyze socio-economic characteristics of respondents. Gross margin analysis was used to estimate costs and returns of banana fruit marketing. Multiple regression analysis was used to determine the effect of socio-economic characteristics of respondents on their income.
The multiple regression model is stated thus:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, , ei).$$

Four functional forms of the model are explicitly represented as follows:
Linear: $Y = a_0 + a_1X_1 + a_2 X_2 + a_3 X_3 + a_4X_4 + ei.$
Semi log: $Y = a0 + a_1 \log X_1 + a_2 \log x_2 + a_3 \log x_3 + a_4 \log x_4 + ei.$
Double log: $\text{Log } Y = a0 + a_1 \log X_1 + a_2 \log x_2 + a_3 \log x_3 + a_4 \log x_4 + ei.$
Exponential: $\text{In}Y = a0 + a_1 X_1 + a_2 x_2 + a_3 x_3 + a_4 x_4 + ei.$

Where
Y = Output of banana marketing (kg)
X_1 = Age of the marketers (years)
X_2 = Household size (No in the family)
X_3 = Educational level (years)
X_4 = Marketing experience (years)
X_5 = Transportation (N),
X_6 = Membership of Association (Member = 1, Non-member =0)
X_7 = Credit (N)
ei = Error term.

Gross margin Model: GM = TR –TVC (GI –TVC)
Where
GM = Gross margin
TR = Total Revenue
GI = Gross income
TVC = Total variable cost

Results and Discussion

The socioeconomic characteristics of the respondents studied were Age (years), Gender, level of education, marital status, Household size among others. Table 1 shows distribution of respondents according to their socio-economic characteristics.

Table 1: Distribution of the Respondents According to Age (years)

	Retailers		Wholesalers	
Variable	Frequency	Percentage	Frequency	Percentage
Age (years)				
Below 30	39	32.5	30	25.0
31 -40	58	48.3	53	44.2
41 – 50	22	18.3	33	27.5
51 – 60	1	0.8	4	3.3
Level of Education				
No formal education	20	16.7	21	17.5
Primary education	16	13.3	27	22.5
Secondary education	69	57.5	60	50
Tertiary education	15	12.5	12	10
Household size				
2 – 4	50	41.7	42	35.0
5 - 7	63	52.5	65	54.2
8 - 10	5	4.2	10	10
11-13	1	0 .8	1	0.8
Greater than 13	1	0.8		
Membership of Association				
Yes	30	25	42	55
No	90	75	78	65
Marketing experience (years)				
1 – 5	22	18.3	8	6.7
6 – 10	49	40.8	47	39.2
11 – 15	47	39.2	50	41.7
Above 15	2	1.7	15	12.5
Source of capital				
Personal savings	67	55.8	55	45.8
Friends	32	26.7	16	13.3
Loan from bank	2	1.7	11	9.2
Thrift	19	15.8	38	31.7

Source: Field survey, 2017

Result shows that majority of the retailers (66.6%) and wholesalers (71.7%) were within the ages of 31 -50 years. This implies that both the retailers and the wholesalers of banana in the study area were still within their youthful and active age. This is in line with the findings of Nwaru (2004), who noted that the ability of a farmer to bear risk, be innovative and be able to do manual work decreases with age .On educational attainment of marketers, majority of retailers (83.3%) and wholesalers (79%) attended formal education. Their level of literacy could enhance adoption of new technologies in marketing. Result is in consonance with findings of Nwaru *et al* (2011), who stated that, education helps for product management and easy access to information. Majority of the retailers (58.3%) and wholesalers (65%) had household size of at least 7 persons. The relatively large family size of banana marketers is to enhance availability of labour needed in banana marketing. Result supports finding of Effiong (2005). Most of the retailers (75%) and wholesalers (65%) do not belong to any marketing association. This implies that marketers do not take membership of marketing association seriously. Marketing associations are important especially in acquiring loans from formal financial institutions. Table I also shows that majority of the retailers (81.7%) and wholesalers (93.3%) have had more than 5 years marketing experience. Long years of involvement in marketing expose the marketers to marketing ideas that will help them to overcome marketing intricacies (Okoye *et al,* 2010). Retailers identified their source of capital to include personal savings (55.8%), friends (26.7%(, thrift (15.8%) and loan from bank (1.7%) while the wholesalers identified theirs to include personal savings (45.8%), thrift (31.7%), friends (13.3%) and loan from bank (9.2%). This implies that the wholesalers have more sources of capital than the retailers in the study area. This may be due to the quantity of their sales. Anozie *et al* (2016) opined that capital is an important factor in production and marketing of products.

Table 2: Result of Multiple Regression on the Effect of Socio-economic Characteristics of Banana Marketers (Retailers and Wholesalers) on their Income

	Retailers				Wholesalers			
Variables	Linear	Expo	Double log+	Semilog	Linear	Expo	Double log	Semilog
Constant	1.469	0.174	0.555	1.951	1.582	0.452	0.533	1.797
	(2.996)***	(0.597)	(3.474)***	(7.242)	(3.490)**	(1.990)**	(3.480)***	(5.958)***
Age	-0.044	-0.056	-0.106	1.178	0.085	0.039	0.155	0.294
	(-0.467)	(-3.394)***	(-3.786)***	(2.507)	(1.066)	(0.979)	(1.696)*	(1.634)
Household size	-0.092	-0.055	-0.083	-0.157	0.095	0.038	-0.003	0.193
	(-4.182)***	(-2.750)**	(-0.835)	(-0.938)	(1.056)	(0.841)	(-0.032)	(6.226)***
Education	0.049	0.039	-0.097	0.164	-0.072	-0.046	-0.326	-0.198
	(0.660)	(0.873)	(-4.407)***	(8.632)***	(-0.986)	(-1.248)	(-3.663)***	(-1.135)
Experience	0.058	0.047	0.093	-0.140	-0.029	0.031	-0.043	-0.041
	(0.695)	(0.955)	(9.300)***	(-0.863)	(-0.462)	(5.167)***	(-0.555)	(-0.272)
Cost of transport	-0.048	-0.052	-0.129	0.182	0.143	0.093	0.235	0.375
	(-0.552)	(-2.080)**	(-3.071)***	(0.851)	(1.752)*	(2.280)**	(2.652)**	(2.155)**
Membership	0.145	0.074	0.147	-1.553	0.192	0.086	0.246	0.516
	(1.883)*	(0.854)	(1.157)	(-2.264)**	(1.515)	(1.960)*	(2.332)**	(2.480)**
Access	0.330	0.154	0.948	0.164	-0.114	-0.069		
	(1.988)*	(1.557)	(1.955)*	(8.632)***	(-0.832)	(-0.898)		
R2	0.631	0.640	0.655	0.651	0.721	0.735	0.801	0.778
F-value	22.510**	22.674***	23.775***	23.727*	22.201**	22.504**	32.471***	22.992**

Source: field survey, 2017 NB:***, ** and * indicates levels of significant at 1%, 5% and 10% respectively. Values in bracket represent the t – values.

The result showed that double log model was chosen as the lead equation in both retailers and wholesalers. The choice was based on the econometric criteria such as the highest R^2 value (0.655), F-value (3.77) and the highest numbers of independent variables that were significant for the retailers. However, R^2 value of 0.655 implies that about 65.5% of the variation in the income of the banana retailers were influenced by the combined effect of the independent variables included in the regression model. On the other hand, R^2 value of 0.801 for the wholesalers indicates that 80% of the variation in the income of the wholesalers is influenced by the combined effect of the independent variables included in the model.

However, age of marketers, their education, experience, cost of transportation and access were the independent variables that influenced banana marketing by retailers in the study area. The coefficient of Age (X_1) was negative and significant at 1% level of probability. This implies that an increase in the age of the marketers will reduce their income by –₦0.106. Education (X_3) was also negative and significant at 1% level. This also indicates that increase in the level of education of the retailers increases their income in the study area. Marketing experience (X_4) was positive and significant at 1% level. The implication is that a unit increase in the experience of retailers in banana marketing will increase their income by N0.093. Cost of transportation (X_5) has negative coefficient implying that increase in cost of transportation reduces the income of the retailers by N0.129. Access to banana (X_7) has a positive coefficient which implies that the more access a retailer has to the goods could increase his/her income by N0.948 in the study area. On the other hand, age, education and cost of transportation were the factors that influence the income of wholesalers in the study area. The coefficient of age (X_1) was positive and significant at 10% level. This implies that the older a wholesaler marketer is, the better he performs in the business. Coefficient of education (X_3) was negative and significant at 1%level, this implies that the more educated a wholesaler marketer is, the greater his income. Cost of transportation (X_5) was positive and significant at 5% level. The implication is that the higher the cost of transportation, the higher the income of the wholesaler in the study area. The coefficient of membership of association (X_6) was positive and significant at 5% level implies that banana wholesalers that belongs to association has more income than those who do not belong to any.

The overall, confidence of the model was confirmed by their f-value which is statistically significant at 1% level. Therefore, socioeconomic characteristics of banana marketers influenced their income in the study area.

Table3: Gross Margin Analysis of Banana fruit Marketing in Ivo Local Government Area of Ebonyi State.

Items	Retailers(N)	Qty	Wholesalers (N)
Purchase price/15kg of banana	2050	375kg	225,000
Transport	150		56,250
Marketing expenses	20		1,000
Miscellenous	100		2,000
Total variable cost	2,320		284,250
Selling price/unit	3,200	2050	768,750
Gross marketing margin (TR – TVC)	880		484,500
Benefit cost ratio (BCR) = TR/ TC	1.4:1		2.7:1

The table 3 shows that the wholesalers purchases 375kg of banana fruits from the producers or their agents at N225,000 and resells to the retailers at N2,050 per 15kg. The retailers resells their 15kg of banana at N3,200. The total variable cost for the retailers was N2, 320 while that of the wholesalers was N284, 250. Gross margin for the retailers was N880 while that of wholesalers was N484, 500. Their Benefit Cost Ratio was N1.4 and 2.7 for the retailers and wholesalers respectively. The implication is that for any N1.00 spent in banana marketing, the retailers get N1.4 and wholesalers get N2.7, indicating that the business is profitable.

Table 4: Distribution of the respondents according to the constraints to banana fruit marketing

Constraints	Retailers Frequency	Percentage	Wholesalers Frequency	Percentage
Inadequate storage facilities	33	27.5	36	30.0
Perishable nature of the product	60	50	30	25.2
Pest and diseases attack	27	22.5	50	42.0
Poor transport system	-	-	30	2.5
Poor access to credit	-	-	1	0.8
Total	120	100	120	100

Source: Field survey, 2017

Table 4 shows that the major problems identified by the retailers as their constraints to banana fruits marketing in the area includes perishable nature of the fruits (50%), lack of storage facilities (27.5%) and pest and diseases attack (22.5%) while the problems encountered by the wholesalers are; pests and diseases (42%), inadequate storage facilities (30%), perishable nature of the fruits (25.2%), poor transport system (2.5%) and poor access to credit (0.8%). This implies that banana marketing is hindered by the identified factors which need to be solved for efficient marketing.

Conclusion

Banana marketing is a profitable enterprise in the study area. Wholesalers and retailers made gross margin of N 484, 500 and N888 respectively per 15kg of banana sold. Their Cost returns analysis show that for every N1 invested N1.4 and 2.7 for retailers and wholesalers were realized respectively. Age of the marketers, their education level, marketing experience, cost of transport and access to credit were the factors that significantly affect retail banana fruit marketing in the study area, while age of the marketers, their educational level, marketing experience, cost of transportation and membership of co-operative association were the factors that significantly affect wholesale banana marketing in the study area. Based on the research findings, the following recommendations were made: The banana marketers (wholesalers and retailers) should form cooperatives to enable them generate a strong source of credit for improved marketing. The government on their own should provide the infrastructure, such as good road, proper storage facilities for the banana marketers in the study area. There is urgent need for the research institute to develop more effective and non-contaminant pesticides that could reduce or solve the problem of pests and diseases as encountered by the banana marketers in the study area.

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Economic Of Rice Productivity in Wase Local Government Area of Plateau State, Nigeria

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Abstract
The study examined the rice farmer's productivity in Wase Local Government Area of Plateau State, Nigeria; the objectives were to estimate profitability of rice farming in the study area and determine the socio economic factors affecting rice farmer's productivity. Primary data was used for this study with the aid of well- structured questionnaire. A multi-stage sampling technique was used in selecting rice farmers in the study area. Three major rice producing districts were purposely selected from the Local Government Area followed by the random selection of the villages from each districts. In all 153 rice farmers were randomly selected from six village's.Gross margin analysis revealed that the production of rice is profitable with the gross margin of ₦216,576.The multiple regression estimates for determinant of productivity among rice farmers reveals that the coefficient of age, educational level and farm size were negatively significant at 1% level while the quantity of seed and fertilizer were positively significant at 5%.Based on the findings of the study, recommendations are necessary for more sustainable rice production in the study area.
***Keywords**: Rice Farmers, Productivity and Gross-margin*

Introduction
Agriculture is the mainstay of the majority of Nigerian rural poor, producing major crops comprising cereal such as sorghum, maize, rice; tubers such as yams, cassava, legume such as groundnut and cowpea as well as vegetables.Rice is cultivated in all regions of Nigeria. It ranks sixth after sorghum, millet, cowpea, cassava, and yam (5). It accounts for about 12 percent of the total cereals produced in Nigeria (6). Five major production systems have been identified, these are the upland rain fed, inland shallow swamp, deep water, floating lowland and irrigated rice production systems (15). In 1990, rice yield in Nigeria was 2.07 tonnes/hectare, this reduced to as low as 1.3 tonnes/hectares in 2007 and in 2012, Nigeria rice yield was 1.88 tons/hectare (11). The land area under rice cultivation in Nigeria in 2005 was about 2.708 million hectares. But the estimated area planted with rice in 2012 stood at 2.685 million hectares (11). This figures indicated a reduction in area cultivated for rice over the period 2005 – 2012.Rice is a major staple food in Nigeria, but its domestic production has never been able to meet the demand; (9,10) observed that the demand and supply gap in rice production is widening, resulting in huge import bill on rice. Rice imports have affected the domestic production and marketing of Nigeria's local rice. This is due to the decreased demand for local rice by Nigeria as opposed to the imported ones. Also, as a response to the prevailing rice supply deficit situation in Nigeria, successive Nigerian governments intervened in the rice sector through the establishment of parastatals and policies since 1970; all these were aimed at encouraging, boosting local rice production and enhancing strategies on food security and livelihoods of Nigerians. First, government established the Federal Rice Research Institute (NCRI) in 1974; National Seed Service (NSS) in 1975; and Operation Feed the Nation (OFN) in 1976. Other Government programmes were the River Basin Development Authority (RBDA) 1977; Agricultural Development Projects (ADP) 1975; The Structural Adjustment Programmes (SAP) 1986; (4). The National Special Programmes on Food Security (NSPFS), National Rice Development Strategy (NRDS) 2009 and Presidential Initiative on Rice (2001), aimed at attaining food sufficiency in local production of rice in the short term (2005) and increase export in the medium term (2007), with targets of 3 million hectare cultivation, and 15 million tons of paddy rice or 9 million metric tons of rice (8). Despite these efforts, rice production

potential has not yet been realized, as small holder (small-scale, subsistence and fadama farmers) output is inadequate and paddy rice processing is still substandard. Also, Nigeria is still the world largest importer of rice (10). In a bid to achieve rice self sufficiency in Nigeria, a rice transformation action plan was set up in 2011 under the umbrella of the Agricultural Transformation Agenda (ATA) and the target was 6.0 million metric tons per annum of locally produced and internationally competitive milled rice by 2015 (7). The importation of rice to bridge the demand-supply gap is worth ₦365 billion (2). The cost of these rice imports represents a significant amount of lost earnings for the country in terms of jobs and income (3).Therefore the main objective of the study is to analyze rice productivity among farmers in Wase Local Government Area of Plateau State, Nigeria.While the specific objective are to:estimate the cost and return of rice producers and to determine the socio-economic factors affecting rice productivity in the study area.

Methodology

The study was conducted in Wase Local Governments Area of Plateau State, Nigeria. It is located about 216 kilometers away from Jos, the State capital, with an estimated population of 209, 311 in 2015 (12). The land covers an area of 4,587 square kilometers.The annual rainfall is 1083mm and 27.4^{o}C average temperature. Major crops grown are food and cash crops as maize, sorghum, rice, groundnut, cotton, vegetables and beans. The major livestock are cattle, sheep, goat, poultry, and pigs.

A multi-stage sampling technique was conducted in three (3) district of Wase Local Government Area. The three (3) districts areKadarko, Lamba and Wase town. The Primary data in the study were obtained from153 rice farmers.This structured questionnaire was used to collect data from the farmers during2014/2015 season. Data were analyzed using gross margin and multiple regressions.

Model specification

Gross Margin Analysis.

Gross Margin is simply the difference between the total revenue and the total variable cost of each unit.

GM =TR-TVC,Where;GM=Gross Margin,TVC=Total Variable Cost,TR = Total Revenue.The variables to be used are:Seed (₦/kg),Fertilizer (N̲/Kg),Agro chemicals (N̲/Kg),Labour (mandays),Transportation (N̲/km).

Total Factor Productivity (TFP)

The Total Factor Productivity is measured as the inverse of the average unit cast of production. It is defined as the inverse of the ratio of total variables cost to total output. The model is approximated by a linear relationship.

(i) Total Factor Productivity Model

(ii)

$$TFP = \frac{Q}{TVC} \quad \text{or} \ \frac{1}{AVC} \qquad (1)$$

where, TFP = total factor productivity, Q = output(yield) and TVC = total variable cost.

$$TFP = F(Z_i, Z_2, Z_3 ...., Z_m) \qquad (2)$$

$$TFP = d_o + d_i z_i + d_2 Z_2 + d_3 Z_3 + ... + d_{10} Z_{10} \qquad (3)$$

Multiple Regression Model

This model was used to determine the socio economic factors influencing the productivity models (total factor).The model is as specified below;

$$Y = F(Z_1, Z_2, Z_3, Z_4, Z_5, ei). \qquad (4)$$

$$Y = b_o + b_1 Z_1 + b_2 Z_2 + b_3 Z_3 + b_4 Z_4 + b_5 Z_5 + Ui \text{ (linear)} \qquad (5)$$

Where Z_1 = age of farmers (yrs);Z_2= level of education (yrs);Z_3 = farm size (ha);Z_4 = seed(₦/kg);Z_5 = fertilizer (₦/kg);Z_6 = labour(mandays);u = error term; β= parameters to be estimated.

Results and Discussion

Gross Margin Analyses of Respondents

The total variable cost consist of seed, labour, fertilizer, chemicals, transportation, land rent,,the total variable cost stood at ₦179,424. Gross Income was ₦ 396,000and the gross margin was ₦ 216,576, while the return per naira increased was 0.83. This means that for every one naira invested, there was a return of 0.83kobo. This implies that production of rice is profitable in the study area.This means that the income generated would help farmers to have a sustainable livelihood.

Table 1: Gross Margin of Rice Productivity in the Study Area

Items	Cost/ha(₦)	Percentage
A: Gross Income (GI)	**396,000**	
B: Variable Cost (VC)		
Seed	9,600	5.4
Fertilizer	32,000	17.83
Agro chemicals	8,752.90	5.0
Transportation	9,750	5.4
Labour:		
Weeding	16,500	9.19
Harvesting	11,540	6.4
Land preparation	40,000	22.29
Sowing/plating	8,350	4.65
Processing and storage	33,431.40	18.6
Land	10,000	5.6
Total variable cost (TVC)	**179,424**	**100%**
C:GrossMargin (GM)	**216,576**	
D: Net Return (NR)	**0.83**	

Source Field survey, 2016

Socio Economic Factors Affecting Rice Farmer's Productivity in the Study Area

The multiple regression shows that R^2 (the coefficient determination) was 0.645. This shows that the variation in the dependent variable Y (output) was influenced by the combined effects of the independent variable (z_1-z_6). This implies that 36% of the variation in rice productivity was accounted for by the inputs included in the model.

Age: This variable is negatively significant at 5%level. This implies that an increase in the age of the farmers would lead to a decrease by the value of -0.584. This support the finding of (1) and (13) which found that age has a negative influence on productivity.

Educational level: This variable is negatively significant at 5% level. This implies that an increase in the education of the farmers would lead to a decrease by the value of -0.426. This support the finding of (1) which found that education has a negative influence on productivity

Farm size: The variable is negatively significant at 5%level. This implies that an increase in the farm size would lead to a decrease by the value of -0.604.

Quantity of seed: The variable has a positive coefficient(0.114) and significant at 1%level. This implies that a unit increase of input will lead to an increase in output.This suggests that the more use of certified seed the more productive the rice farmer.

Quantity of fertilizer: This variable has a positive coefficient(0.664) and significant at 1% probability level. This implies that the higher the use of fertilizer the more productive the rice farmer become.This support the finding of (14) which observed that the use of fertilizer increased agricultural productivity of crop farming in the dry savannah and humid forest agro-ecological zones of Nigeria.

Table2: Multiple Regression Rice Productivity in the Study Area

Variables	Coefficient	Standard error	t- ratio
Constant	0.395	0.461	0.856
Age	-0.584	0.226	-2.464**
Education	-0.426	0.189	-2.25**
Farm size	-0.604	0.297	-2.023**
Seed	0.114	0.042	2.704***
Fertilizer	0.664	0.232	3.136***
Labor	0.635	0.529	-1.200^{NS}
R^2	0.645		

Conclusion/Recommendations

On the basis of findings, it was concluded that rice production in WaseLocal Government Area of Plateau State is profitable given improved seed, available climate and soil requirement. It was recommended that more revenue can be made by farmers if availability of agricultural inputs are subsidized which could help them to have a sustained livelihood.

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Economic of Sorghum Production in Kachia Local Govrnment Area of Kaduna State, Nigeria

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Abstract
The study examined the economics of sorghum production in Kachia Local Government Area of Kaduna State. A multistage sampling technique was used to select 80 respondents used in the study. The analytical tools used include, Farm budgeting technique, production function and resource use efficiency. The result shows that sorghum production is profitable with the total cost of production (TC) being ₦ 47459.9 per/ ha while total Return (TR) was ₦ 78093.2. Per/ha, net income stood at ₦ 30633.3 while the return to investment was ₦ 1.64. The R^2 was 0.81% Coefficient of input shows that labour, and fertilizer were positively significant at 1 percent each, while seed was negatively significant at 1 percent. The study also revealed that seed is less than (<) the MFC. This indicates that seed is over utilized. This can be attributed to the variability of seed in the production of sorghum, while on the other hand, the MVP of labour, fertilizer and herbicide are greater than (>) as MPC. This indicates that labour and herbicide inputs are under-utilized, which implied that labour, fertilizer and herbicide inputs need to be used. The underutilization of purchased inputs might be due to improper management practices. It is recommended that with time and policy change these small scale farmers will improve their production income and they will grow to become major producers in order to sustain livelihood.
Keywords: *Sorghum, Farmers, Production, Kaduna State.*

Introduction
Sorghum (*Sorghum bicoloi*) is one of the most important staple crops in Nigeria and is the most important cereal food in the northern state that covers the guinea savannah ecological zone (FAO, 2005). In term of food contribution, Sorghum is the major cereal consumed by the majority of the population (NAERLS, 1997)). In the northern state about 73% of the total calories intake and 52.3% of the per capita protein intake are contributed by sorghum alone (Samm 2009). Some sorghum varieties are rich in antioxidant and all sorghum varieties are glutan free, an alternative for wheat allergy (Annon2, (2010). It is one of the most drought cereal crops currently, under cultivation. It offers farmers the ability to reduce cost on irrigation and other farm expenses. It requires an average temperature of at least 25^{o}c to produce maximum yield. In general is a very competitive crop and does well in competing with weed in narrow rows (FAOSTAT, 2010). Nigeria have resulted in the development and release of sorghum varieties suited to specific ecological (Aba et al (2004). Agricultural contribution to the National economy has been dwindling, this is so given that Nigeria has varied and complex constraint militating against the realization of increased agricultural output, among which are low crop yield, use of no improve crop varieties, inconsistent micro-economy policy, poor input and pests outbreak have also contributed to this situation (12). This makes sorghum the second most important cereal grain in Africa after maize.

According to (Akinleye, 2006) the production of commodities is not given consideration due to decline in output of the commodities in the savannah zone. Sorghum is grown and estimated as 4.5 million per ha with an annual production output of about 6 million tons (NAERLS, 1997)). Therefore to increase sorghum productivity, there is a need to understand the efficiencies of production since increase in production is directly related to productivity of the farmers which could help them to enhance food security and livelihoods in Nigeria. These require knowledge of aggregate farm level resource availability and difference in the productivities of these resources. This paper attempts to provide some useful information on policies towards increase in sorghum productions. Therefore, the broad objectives of the study are to analyze the economics of sorghum production in Kachia Local Government Area of Kaduna State. While the specific objectives are to: estimate the cost and return of the sorghum production in the study area; determine the resources-use efficiency of sorghum production in the study area.

Methodology

The study was carried out in Kachia Local Government Area of Kaduna State. It has land mass area of 4,632 kilometer square and estimate the total population of 350,275 people according to 2014 estimate population census. The Local Government is situated between latitude $9^0$25W and $10^0$20W and longitude $7^0$45E and $8^0$40E.The area has a temperature of 10^0C with severe cold in the month of December, January and early February. Rainfall distribution ranges from 550 – 900mm. Subsistence farming is the main source of livelihood in the area and crop cultivated include, maize, groundnut, ginger, soya beans, millet and guinea corn.

A multistage sampling technique was used in the study. Four (4) out of eight (8) districts were selected due to the high production of sorghum in the area. Two villages were chosen from each of the four (4) district selected. The villages' include: Dackham, Gidan Jibir, Tunga, Jaban Kogo, Fadan, Gidan Mana, Dangyolmi and Sabon Sarki. Based on the population of the villages 15% of the population was used to determine the number of respondent to avoid bias. 80 farmers were randomly selected.. Primary data was used in the research. The primary data were open and close ended type of questionnaire and oral interview. Data were analyzed using net farm income and resource use efficiency.

Model Specification

Net Farm Income

The farm budget techniques were used in this study. The net farm income is expressed as follows:

NFI = GFI – TC.

Where;

NFI = Net farm income,
GFI = Gross farm income
TC = Total cost
TC = TFC + TVC
TVC = Total variable cost,
TFC=Total fixed cost
The variable to be used includes:
Seed (₦/kg)
Labour (man per/day)
Fertilizer (₦kg)
Herbicides (₦/litters)
Land rent (₦)
Depreciation on equipment (₦)

Production Function Model

Production function model was used to examine in the input-output relationship in sorghum production and it was given as:

$$Y = f(X_1\ X_2\ X_3 \ldots\ldots\ldots\ldots\ldots Xn)$$

Where;

Y= Output of sorghum in kg
,x_1= Seed (kg)
x_2=Labour (man per/day)
x_3= Fertilizer(kg)
x_4= Herbicide(litters)
E=Error disturbance term.

The relationship was expressed in explicit cob- Douglas production form (double log) as follow:-

$$\text{Logy} = \log a0 + b_i \log x1 + b_2 \log x\ 2 + b_3 \log x\ 3 + b_4 \log X4$$

Resource use Efficiency
Resource use efficiency was used to satisfy objective (iii) of the study. The efficiency of resource use was determined by the ratio of marginal value product (MVP) to marginal factor cost (MFC) of input based on the estimated regression coefficient following (Mohammed, 2008) efficiency of resource, r, is give as:

$$MPP = \frac{bi\,y}{X_1} \quad MVP = bi\,\frac{y}{x}.Py$$

$$r = \frac{MVP}{MFC}$$

The rule provides that when r = 1 there is efficient use of a resource; r > 1 indicates under-utilization of resource while r < 1 means over utilization of resources. The equation is stated as follows:

$$MVP = MPP \times PY.$$

Where
r = efficiency ratio
MVP=Marginal Value Product
MPP=Marginal Physical Product
MFC=Marginal Factor Cost
Pxi (unit price of input x1)
Y=Arithmetic mean value of output
X_1=Arithmetic mean of input considered
Py= Unit price of output.

Result and Discussion

Net Farm Income
The total cost of production include; the variable and fixed cost. The total variable cost consist of seed, labour, fertilizer, chemicals, land rent, while total fixed cost consist of depreciation of equipment. The total variable cost stood at ₦39959.9 while the total fixed cost stood at ₦ 7500. Fertilizer cost constituted the highest fraction of 62%, followed by land rent at 13% while seed, labour, chemicals at 3% each. Total revenue was ₦ 78093.2, total cost of production was ₦ 47459.9, and the net farm income was ₦ 30633.3, while the return per naira increased was ₦ 1.64. This means that for every one naira invested, there was a return of 1.64kobo. This implies that production of sorghum is profitable in the study area, which means that through sorghum production the farmers could improve their food security status and their livelihoods.

Table 1: Cost and Return of Sorghum Production in the Study Area

VARIABLE COST (VC)	VALUE (₦ /HA)	PERCENTAGE (%)
Seed	1444.7	3.04
Labour	1422	3.00
Fertilizer	29527.7	62.22
Chemicals	1565.5	3.30
Land rent	6000	12.64
Total Variable Cost (TVC)	39959.9	
Fixed cost (FC)		
Depreciation of equipment	7500	15.80
Total fixed cost (TFC)	7500	
Total cost of production (TC)A	47459.9	100
Total returns (TR)B	78093.2	
Net Income B-A	30633.3	
Return per naira invested (TR/TC)	1.64	

Source: Field Survey, 2014.

Production Function of Sorghum Production

The R^2 which is the coefficient of determination was 0.81% this means that 0.81% of the variation in output of sorghum production was determined by the explanatory variables included in the model. The coefficient for labour, fertilizer, herbicide are positively significant, this implies that an increase in units of the same input will result in increase in output but in the case of herbicide it was found not to be significant. Amongst all the variables used, seed is the only variables with a negative co-efficient which agrees with (14) in the project titled economic of sorghum production in Bauchi Local Government Area of Bauchi State with seed having negative signs. This implies that, in any increase in unit, production lead to the total decrease in the output to about – 0.333kg.

Table 2: Production Function of Sorghum Production in the Study Area

Variables1	Coefficient	Standard Errors	T-Radio
Constant	1.555	1.218	1.276
Seed	- 0.333	0.118	-2.822 ***
Labour	0.505	0.135	3.749 ***
Fertilizer	0.063	0.024	2.625***
Herbicide	0.085	0.448	0.190NS

Source: Field Survey, 2014

R^2 = 0.81
*** = Significant at 0.01 % (P<0.01
NS = Not Significant

Resource Use Efficiency

From the below table, the MVP of seed is less than (<) the M.F.C. This indicates that seed is over utilized in the study area. This can be attributed to the variability of seed in the production of sorghum in the given area. While on the other hand, the MVP of labour fertilizer and herbicide are greater than (>) as MPC. This indicates that labour, fertilizer and herbicide inputs are under-utilized in the study area. This implied that labour, fertilizer and herbicides inputs need to be used.

Table 3: Resource Use Efficiency in Sorghum Productionin the Study Area

Variables	MPP	MVP	MFC	MVP/MFC
Seed	1.244	-99.52	100	-0.99
Labour	13.02	1301.5	500	2.60
Fertilizer	1.68	252.65	150	1.68
Herbicide	20.45	24540	1000	24.54

Source: Field Survey, 2014

Conclusion/Recommendations

Sorghum production in Kachia Local Government Area is a profitable venture as shown in this study. Moreover, like other agro-business, it is faced with a lot of challenge or constraints that need urgent attention to be tackled to improve the situation of sorghum production. It is however believe that with time and policy change these small scale farmers will improve on their performance and grow to become major producer of sorghum in Kaduna State and in Nigeria at large in order to enhance sustainable livelihood and food security.

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Gender and Agricultural Land Access: a Discriminant Function Analysis Approach

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Abstract
In the developing world, while many people lack secure land right and access to adequate land resources, women have been found to have less access to land than their men counterpart do. This study investigated the factors that best predict how access to land was gained by farmers in the area. This study was particularly carried out with a view to engendering appropriate policy response towards female access to land in the area. Multistage sampling technique was used in selecting 120 respondents used for this study. Data collected were analysed using discriminant function analysis. The result showed that the means of gaining access to land in the study area include community, purchase, lease/rent, inheritance, and gift. Discriminant function analysis was used to determine which socio-economic variables were the best predictors of how access to land was gained. The study found gender of the farmer amongst the best predictors of how access to land is gained in the area. The study therefore concluded that gender biasedness with regards to land access exists in the area, and in favour of the male farmers. It is therefore recommended that the redesigning and redeveloping of the structure of land policies to be more gender sensitive and inclusive.

Key words: land, gender, agricultural, access, farmers.

Introduction
In the discourse of agriculture and its related activities, there is one major factor that cannot be ignored- land. Land is crucial resource for the production of biomass, ensuring food, fodder, renewable energy and raw materials for the sustenance of human and animal life (Adekola *et al*., 2013). In many developing countries, land is a valuable form of asset, given its economic, political symbolic and ritual importance (Bioye *et al.,* 2006). In the agrarian communities of Nigeria, land is not just a factor of production but a major determinant of the people's livelihoods. Land provides the rural household the basic means for the subsistence production of their food need and for market production to generate income. Consequently for the poor rural households land access is an important basis for their economic and social development.

However, in past few years, access to and equitable distribution of land, and other land tenure issues are points of serious controversy in Nigeria. Increasing farmers are faced with the challenge of accessing available land. The constraints is multiplied for the women, as existing rules and traditional practices in relation to land acquisition are biased in the favour of males (Lasterria-Cornhiel & Gracias, 2009). For example, some cultures in Nigeria, through marriage and inheritance practices, discriminate against women from owning or accessing land. Emeasoba, (2012) reports that due to legal or cultural restrictions women usually have very little or no control over resources, particularly land.

This is regarded a major challenge to sustained agricultural production, when considering that women constitute a large proportion of farm labour and agricultural workers. Also these women are responsible for the production of the bulk of the country domestic food. Afolabi (2008), reports that in some Nigerian states, rural women are majorly responsible for production and processing of arable crops, producing as much as 80 % of the staple food items. The sustainability of the cultivation and production of these staple food crop depends on the enormous availability of land to the women. With the constrained access to farmland for the women, it is expected that domestic food production levels would reduce drastically, consequently affecting the food security of the country.

Therefore, for the success of any meaningful agricultural development, ownership or sustained access to land is paramount. Given the potential role of women in sustaining the agricultural sector of the country and the consequences of inequality on land access across gender. This study therefore sought to identify the socio-economic factors determining the means through which land is accessed in the area, with gender being a variable of interest. This is necessary in order to identify issues that must be resolved in the fight against gender biasedness in access to agricultural resources. Moreso, the study is undertaken so as to sharpen the focus of advocacy for equitable integration of women and men in agricultural land access and for the sustained agricultural production in the country. The specific objectives for the study was to analyse the factors that best predict how access to land is gained, with a view to engendering appropriate policy response towards female access to land in the area.

Methodology

The area for the study was Ekiti State, Southwest Nigeria. Ekiti State lies South of Kwara State and Kogi State, East of Osun State and West of Ondo State. The state enjoys tropical climate marked by two major seasons. The seasons include the rainy season which last from April to October and the dry season from November to March. The state provides home to a population of 2,801,161 people (National Bureau of Statistics, 2012). The indigenes of the state belong to the Yoruba ethnic group. Agriculture is the main occupation, providing income and employment for majority of its population. Cocoa, coffee, kolanut, cashew and oil palm are the major cash crops grown in the state. Examples of arable crops grown in the state include yam, cassava, maize, cowpea and cocoyam (Ekiti State Government, 2008). The study used multi-stage sampling technique to draw a sample for the study. At the first stage, 6 local government areas were purposively selected from the sixteen local government areas that constitute the study area. This local government areas were purposively selected based on their degree of involvement in farming. In the second stage, two communities were randomly selected from each of the six local government areas selected, giving a total of 12 communities. In the final stage, ten respondents with equal number of male and female were randomly sampled from each of the communities. This gives a total of 120 respondents for the study. Primary data were collected for the study with the use of a structured questionnaire. Data obtained was analysed using discriminant function analysis.

Discriminant Function Analysis Model

The model was employed in order to determine the variables that are best in discriminating between groups of people based on how they gained access to land. The predictors (independent variables) were the socio-economic characteristics of respondents including: sex, marital status, educational status, income level and occupation. The grouping (dependent variable) was the means of gaining access to land namely community, purchase, lease/rent, inheritance, and gift.

Mathematically, the model is expressed as:

$D = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4$

Where:

D= Discriminant score

a= constant (intercept)

b= Discriminant coefficients

x_1= Sex

x_2= Membership of cooperative

x_3= Monthly farm income

x_4= Age of farmers.

Result and Discussion

Discriminant function analysis was employed to determine the best predictors of access to farm land in the study area. The result of the statistical test of significance of the model is presented in table 1. The table shows the efficacy of the discriminant function.

Table 1. Statistical Parameters of the Correlation

Eigenvalues

Function	Eigen value	% of Variance	Cumulative %	Canonical Correlation
1	1.091[a]	97.5	97.5	.770
2	.291[a]	1.8	99.2	.475
3	.123[a]	.7	100.0	.331
4	.004[a]	.0	100.0	.062

a. First 4 canonical discriminant functions were used in the analysis.

The canonical correlation of 0.770 for Function 1 suggests the model explains 97.5% of the variation in the grouping variable that is whether a farmer accesses land through community, purchase, lease/rent, inheritance, or gift. Function 2 and 3 having canonical correlations of 0.475 and 0.331 suggests the model explains 1.8% and 0.7% of the variation respectively. This shows how good the model is in explaining the variation in the grouping variables. Moreso, the table indicated eigenvalues of 1.091, 0.291, 0.123 and 0.004. A low eigenvalue obtained is an indication of near linear dependence in the data obtained for the study. Thus the model is free of multi-co linearity. This agrees with the work of Nto *et al*., (2014) that got Eigen value of 3.116. However, when eigen value is less than 8, the result is considered as excellent.

Moreover, the Wilks' Lambda indicates the significance of the discriminant functions and provides the proportion of total variability as explained in Table 2. It tests how well each level of independent variable contribute to the model. The scale ranges from 0 to 1, where 0 means total discrimination and 1 means no discrimination.

Table 2: Wilks' Lambda

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 4	.040	753.548	16	.000
2 through 4	.687	87.913	9	.000
3 through 4	.887	28.078	4	.000
4	.996	.901	1	.343

In Table 2, function 1, 2 and 3 indicates a highly significant function ($p < .000$) and provides the proportion of total variability not explained. Function 1, 2 and 3 are closer to zero than function 4 which means they tend towards total discrimination, 0, than no discrimination, 1. The smaller the lambda for an independent variable, the more that variable contributes to the discriminant function and it varies from 0 to 1. Hence, it could be concluded that there was a relationship between the dependent variable and the independent variables.
Furthermore, the structure matrix table as shown in Table 3 reveals the correlations of each variable with the discriminant function.

Table 3: Structure Matrix

Structure Matrix

	Function			
	1	2	3	4
Membership of cooperative group	.224	.894*	.024	.387
Sex	.351	-.762*	-.116	-.531
Age of farmers	.161	.294	.114	.935*
Monthly farm income	.031	.472	.612	.633*

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions
Variables ordered by absolute size of correlation within function.

*. Largest absolute correlation between each variable and any discriminant function

Identifying the largest loadings for each discriminant function gives an insight into how to name each function. The table, however, shows that in function 1, sex has the largest absolute correlation,

in function 2 membership of cooperative has largest absolute correlation, in function 3 monthly farm income, while in function 4 it is age of farmers. This means sex, membership of cooperative, monthly farm income, and age of farmers are the best predictors of how access to land is extended in Ekiti State Nigeria.
Overall, the result of the discriminant function analysis confirms that sex of the farmers is an important factor that predicts how access to land is extended in Ekiti state. The study findings confirms the assertion of Adekola et al., (2013) of the prevalence of gender differences in land accessibility in South west Nigeria, as male were found to have more access to agricultural land than their female counterparts. Also, the study finding is in line with the study of Ekenta et al., (2012) in South east Nigeria, who reported that land holding in hectares favours males than females in the area. Similarly, the study findings is in agreement with the study of Onumadu and Onuoha (2015), who found that male farmers had more land holding in hectares than females in the study area.

Conclusion and Policy Implication

The study looked into the factors that determine how access to land is gained by both male and female farmers. The Discriminant function analysis was used to determine which socio-economic variables were the best predictors of how access to land is gained in the area. Sex, membership of cooperative, age and monthly income emerged as the best predictors. The result of the discriminant function analysis confirms that gender of the farmers is an important factor that predicts how access to land is extended in Ekiti state. Consequently, the result of this study reiterates the importance of gender mainstreaming in agriculture. There is the need for the restructuring of land tenure policies in such manner that will ensure that both genders have equal access to agricultural land. Improving women access and tenure security over land is considered a strategically important step in combating food insecurity prevailing in the country.

Based on the study findings, it is recommended that governments at all levels should consider gender in agriculture by revisiting the system of land holding in order to include the vulnerable group such as women farmers. Both male and female farmers should have equal access to agricultural land especially for perennial crops and the farmers should be able to obtain land on a more permanent basis. This will have a significant effect on food production in Ekiti State and in Nigeria at large.

Furthermore, there is a need for enactment of law that will abrogate all traditional and customary practices that disadvantaged women in the ownership of landed properties. Enactment of such laws should not be as a written paper document only but it should be backed up by effective implementation. Financial incentives should be given to the farmers, especially the women folk to enable them access more land and expand their scale of production. Farm inputs and other appropriate types of technology to cater for the labour intensive farm activities, should be available to farmers at affordable and subsidized rates as and when needed. Also, government agricultural policies and programs should not be gender biased.

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Economic Analysis of Maize Marketing in Kiru Local Government Area of Kano State, Nigeria

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Abstract
The study analyzed maize marketing in Kiru Local Government Area of Kano State, Nigeria. Data for the study were collected using structured questionnaire which was administered to 120 maize marketers out of which 115 were retrieved. Descriptive statistics were used to analyze the data. The result indicated that majority of the maize marketers in the study area were men, with the age range of 41-50 years. Also most of the respondents had 1-10 people in their household. The result indicated marketing margin of 26.78%, which implies that 26.78% is the difference in the price incurred as the produce moves from one stage to another in the marketing channel. The main constraints faced by maize marketers in the study area include large number of middlemen, inadequate capital, high transportation cost and inadequate storage facility. The study showed that large number of middlemen was a major (80.9%) constraint. Thus the study recommends that government should create policy that will reduce the number of middlemen in maize marketing system. It is also recommended that marketers should be linked with financial institutions through the help of extension agents in order to secure loans so as to expand their business.
Keywords: Economic analysis, maize, marketing, Kiru, Kano State.

Introduction
Maize (*Zea mays L.*) is a member of the grass family (gramineae). It originated from South and Central America. It was introduced to West Africa by the Portuguese in the 10th century (Iken and Amusa, 2004). Nigeria is currently the tenth largest producer of maize in the world, and the largest maize producer in Africa, (International Institute of Tropical Agriculture (IITA), 2012). It was estimated that 70% of farmers were smallholders accounting for 90% of total farm output (Cadini, and Angelucci , 2013). Marketing is often concerned with all the stages of operations which aid the movement of commodities from the farms to the consumers (Akanni, 2011). These stages include assembling of goods, transportation, processing, grading and financing of all these activities. He also defined marketing as the process of planning and executing the concept, pricing, promoting and distribution of ideas, goods and services to create exchange that satisfies individual and organizational objectives.

Majority of agricultural markets in Nigeria are inefficient and poorly integrated (Onyuma,*et al.,* 2006). The development of an efficient marketing system is essential in the allocation of scarce resource for production and distribution of commodities among consumers (Acharya and Agarwal, 2011) and ensures stable and remunerative incomes to farmers (Ikudayisi and Salman, 2014). Moreover, remoteness, scarce and poorly maintained roads, inadequate transport and storage facilities, and difficulties in accessing reliable information on products and prices prevent the smallholder farmers from participating in competitive markets, often restricting them to non-contestable markets dominated by a few, powerful purchasers (World Bank, 2007). Also middlemen intervention raise price for consumers, which showed that famers encounter high production but hardly get fair pricing of their product from the middlemen, the bulk farm gate buyers. The real profit goes to the middlemen who buy up the farm products at almost give away prices. Based on this background, the study seeks to describe the socio-economic characteristic of maize marketers in Kiru Local Government Area, determine the marketing margin and identify the constraints faced by maize marketers in the study area.

Methodology

The study was conducted in Kiru Local Government Area of Kano State, Nigeria. Kiru Local Government Area (L.G.A.) has land area of 927 km^2, and has estimated population of 264,781 based on 2006 census, (National population commission (NPC, 2006), The projected population for 2017 using annual population growth rate of 3.5 % is 288,840. The people of the community are predominantly farmers, the common crops grown in the area include: maize, sorghum, rice, millet, cowpea and groundnut. The area has two main seasons, wet and dry, the wet season starts at the end of May and ends in September- October and the dry season starts in October and ends in April. Dry cold and dust wind (Harmattan) is experienced between November and February and weather is always cold. Heat is more severe in March and April. The climatic condition is Guinea savannah with grassland vegetation and scattered trees (KNARDA, 2011). Kiru Local Government has 4 major functioning markets. Based on the information collected from maize marketers union, the following information were obtained : Kafin-maiyaki (Kwanar dangora) with 82 maize marketers, Rahama rawun, 66 maize marketers, Yako 47 maize marketers and Kiru 55 maize marketers, making total of 250 maize marketers within the four markets in the study area. The four markets were selected purposively due to high concentration of maize marketers. A total sample size of 120 respondents was selected randomly which represents 48 % of the sample frame (250).

Primary data were used for the study. Data were collected using structured questionnaire complemented with interview schedule. Descriptive statistics such as frequency distribution, range and percentages were used to achieve all the objectives of the study. Marketing margin refers to the difference between the retail price and farm level price. According to Ajala and Adeshinwa (2008) it is expressed as follows:

$$\text{Marketing margin} = \frac{Conumer\ price - Producer\ price}{Consumer\ price} \times 100$$

Where:

Producer price = is the price at which the producer is giving out his produce for sale.
Consumer price = is the price incurred at different stage of time, place, form and possession.

Results and Discussions

The result in Table 1 revealed that 88.7 % of the respondents were male, while 11.3 % were female. This could be because of the socio-cultural belief of the people in the study area. This is in line with studies carried out by Faith *et al.,* (2011). Men were the highest participants (89.24%) in maize marketing in Kano State. Most (41.7%) of the respondents were found to be within the age range of 41 – 50 years, then 30.4 % were within the age range of 31 – 40 years. This implies that most of the marketers were at their active production years. And this is similar to the age range of 30 to 50 years which was found by Onu and Iliyasu., (2008) among maize marketers in Adamawa State. In addition, 91.3 % of the respondents were married while that 8.7 % of the respondents were single. This indicates the ability to take household responsibilities. It also corresponds to the study carried out by Oladopo *et al.* (2007) which indicated that maize marketers in Nigeria were mostly married. The study also shows that 52.2 % of the respondents had no formal education.

Table 1: Socio-economic characteristics of the respondents

Variables	Frequency (N=115)	Percentage (%)
Sex of Respondents		
Male	102	88.7
Female	13	11.3
Age Distribution		
21-30	16	13.9
31-40	35	30.4
41-50	48	41.7
51-60	16	13.9
Marital status		
Single	10	8.7
Married	105	91.3
Household size		
1-10	60	52.2
11-20	50	43.5
21-30	3	2.6
31-40	2	1.7
Level of education		
No formal education	60	52.2
Primary	27	23.5
Secondary	24	20.9
Tertiary	4	3.5
Years of experience		
1-10	72	62.6
11-20	38	33.0
21-30	4	3.5
31-40	1	0.9
Cooperative membership		
Yes	80	69.6
No	35	30.4
Sources of capital		
Formal credit institution	18	15.7
Informal credit institution	28	24.3
Personal savings	69	60.0

Education is very important as it helps the respondents in adopting new marketing strategy, and increases their access on marketing information. This could have effect on the adoption of new marketing strategies. This is contrary to the findings of Onu and Iliyasu (2008) who indicated in their study that majority (56%) had formal education. The study reveals that 62.6 % of the respondents had been involved in Maize marketing for 1 – 10 years, 33 % had of marketing experience, 11 – 12 years, 3.5 % had 21 – 30 years, while 9 % had 31 – 40 years of experience in maize marketing in the study area. (Table1). This shows that majority (62.6%) of the respondents had experience in maize marketing. Also 69.6 % of the respondents belong to co-operative group, while 30.4 % do not belong to any co-operative group (Table 1). This could be an avenue for the marketers to interact with one another through which information diffuse among them. It also implies that the marketer, have opportunity to access loan from bank which will help them to raise their marketing. The result also shows that 15.7 % of the respondents sourced their capital from formal credit institutions, 16.5 % sourced their capital from informal credit institutions, 60 % sourced their capital through personal saving, while only 7.8% sourced their capital from Co-operative society (Table 1) this indicated that most of the marketer (60%) were used personal saving, for their business. This could limit the expansion of their business.

Marketing Margin

Marketing margin for a particular commodity has been defined as the difference between what the consumer pays for the final product and the amount the producer receives, at each intermediary level, it is the difference between price received on resale and the purchase price (Gabre and Madhin, 2001).

Determination of marketing margin

The following formular was used to calculate the marketing margin according to Olukosi *et. al*. (2008).

$$\text{Marketing margin} = \frac{Consumer\ price - Producer\ price}{Consumer\ price} \times 100$$

ΣPP = ₦ 505, 480
ΣCP = ₦ 690, 320

Where:

Σpp = Sum of producer price
Σcp = Sum of consumer price
₦ = Naira

$$\text{Average producer price} = \frac{\Sigma pp}{N} = \frac{₦\ 505{,}480}{115} = ₦\ 4{,}395.48$$

$$\text{Average consumer price} = \frac{\Sigma cp}{N} = \frac{₦\ 690{,}320}{115} = ₦\ 6{,}002.78$$

Where: Σpp = Sum of producer price Σcp = Sum of consumer price N =Number of respondents.

$$\text{Marketing margin} = \frac{Average\ cp - Average\ pp}{Average\ c} \times 100$$

$$\text{Marketing margin} = \frac{₦\ 6002.78 - ₦\ 4395.48}{₦\ 6002.78} \times 100 = 26.78\%$$

This implies that 26.78% is the difference in the price incurred as the produce moves from one stage to another in the marketing channel.

Constraint in Maize Marketing

The main constraints faced by maize marketers in the study area include large number of middlemen (80.9%), inadequate capital (79.1%), high transportation cost (77.4%), and inadequate storage facility (67.8%). Other constraints include inadequate market information (55.7%), price fluctuation (54.8%), Grading and standardization (50.4%), and others which include inadequate good roads and inadequate processing facilities (50.4%). (Table 2)

Table 2: Distribution of respondents according to their constraints

Constraints	Frequency*	Percent (%)
Large number of middlemen	93	80.9
Inadequate capital	91	79.1
High transportation cost	89	77.4
Inadequate storage facilities	78	67.8
Inadequate market information	64	55.7
Price fluctuation	63	54.8
Grading and standardization	58	50.4

*= Multiple responses

Conclusion and Recommendations

The study revealed that the difference between the producer's price and the consumers was 26.78%. This implied that maize marketing in the study area was profitable. The major constraints faced by maize marketers in the study area were: Large number of middlemen, inadequate capital, and high transportation cost, inadequate storage facilities and inadequate market information. Based on these findings it is recommended that Government should implement policy that will reduce number of middlemen involved in maize marketing. This can lead to high cost of maize in the market as long chain of middlemen take a large amount from the consumer's income. Also, the study recommended that marketers should be encouraged by extension agents to secure loans from financial institutions in order to expand their business. Local Government can assist the marketers by providing good road networks as this could reduce transportation cost. Based on the findings, inadequate market information was among the main (55.7%) constraints. It is recommended that Government should set up a Market Information System (MIS) in order to improve the availability and accessibility of market information. Better market information services would enable market agents to read price signals more accurately and promptly, and therefore to make more reliable price forecasts that would aid them in making correct marketing decisions.

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Food Insecurity Status of Farm Households during Post-Planting Season in Oru East Local Government Area of Imo State, Nigeria

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Abstract
This study was conducted in Oru East Local Government Area of Imo State, Nigeria. Specifically the study assessed food insecurity status of farm households during post-planting season in Oru East LGA and determined factors influencing food insecurity of the farm households during post-planting season. Multistage random sampling technique was employed in selecting 84 farm households from whom data were collected using semi structured questionnaire. Data were analyzed using descriptive statistics, food security indices, and Probit regression model. The farm households posted food insecurity line and food insecurity incidence of 1811.68 Naira and 0.466 respectively and food insecurity gap and severity of 0.418 and 0.291 respectively. Probit regression result showed that gender, level of education, amount of credit accessed, farm income, household size, remittances and off-farm income were significant determinants of farm households' food insecurity status. Efforts to improve access to credit by farm households and the promotion of off-farm activities as alternative livelihood options should be pursued by both the local and state governments.
Key words: Farm households, food insecurity, post-planting season

Introduction
Food security is defined as a situation that exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life (FAO, 1996). Temu and Msuya (2004) stated that food security is the guarantee of the physical availability of and economical accessibility to sufficient food (produced with bioenvironmental and sustainable social methods) in terms of quantity (amount, distribution, calories) and quality (safe, nutritious, balanced). Food security has been identified to incorporate food availability, food accessibility, utilization and stability of food access as its elements (Bonnard, 1999). The international community has long been concerned about eradication of hunger and undernourishment especially of vulnerable groups. Despite resolution to enhance food security globally, report on world food insecurity highlighted that number of people suffering from hunger globally has increased every year since 1996 (Abimbola and Kayode, 2013). According to FAO (2010) about 925 million people worldwide still suffer from chronic hunger, in which 235 million hunger sufferers are from sub-Sahara Africa. Available evidence indicates that on almost every indicator such as per calories intake, export earnings, per capita income and food imports, Nigeria exhibits high levels of food insecurity (Akpan, 2009).

With more than 60% of Nigerians engaged in agriculture either as a primary or secondary occupation and producing farm products for their own use and market sales, food security is closely tied to agricultural productivity. This is because higher production on one's own farm improves the food security status of the household and vice versa (Abimbola and Kayode, 2013). Most foods produced by farm households in Nigeria are consumed, or sold for cash only to be repurchased when household barns run short with supplies (Emerole *et al.,* 2014). This cyclic and unstable condition most times leaves affected farm households in a state of insecurity with food supplies especially during the post planting season. The problem of food insecurity during the off season period among farm households in Nigeria is long standing (Obamiro *et al.,* 2005). This is because immediately after harvest most farm households are food secure as they have enough food from own production. However, owing to inadequate processing and storage facilities and the fact that these households have other important needs, they usually end up selling their excess produce at low prices during the harvest period only to require them during off-season. This leads to inconsistent food availability and accessibility thus contributing to household food insecurity during the period. An investigation of the food insecurity status and factors that influence food insecurity status of farm households during the post-planting season in the study area will provide clear information about what needs to be done to ensure food security among farm households particularly after planting season when they are most vulnerable to food insecurity.

Methodology

This study was carried out in Oru East Local Government Area (LGA) of Imo State, Nigeria. The LGA has an area of 136km^2 and a population of 111,822 persons (NPC, 2006). The LGA is bounded to the West by Oru West LGA, to the East and South-east by Njaba and Mbaitolu LGAs respectively, to the North by Orsu LGA and to the South by Oguta LGA, all in Imo State. It lies approximately within latitudes 06^0 45′ and 07^0 15′ north of the Equator and longitudes 06^0 50′ and 07^0 25′ east of the Greenwich meridian. The population for the study comprise of all farm households in the study area. Multi-stage random sampling technique was adopted in selection of sample. First, four communities were randomly selected. Next three villages were randomly selected from each of the selected three communities to give twelve villages. Lists of farm households in each village were formulated with the help of extension agents and village secretaries. This list served as the sampling frame from which seven farm households were selected randomly. Thus, eighty four farm households were selected for the study

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Data were collected with a pre-tested semi structured questionnaire administered through interview method. The survey was conducted in October, 2017 and data were generated on socio economic characteristics of farm households and value of household monthly food expenditure and consumption. Descriptive statistics was used to examine socio-economic characteristics of the farm households in Nigeria and to profile the food insecurity status of the respondents by selected socio-economic variables. The descriptive tools used include means, frequencies and percentages. The need for such analysis is predicated on the fact that a households‟ food security status is largely a function of social and economic characteristics. A Probit model was employed in determining factors influencing the food insecurity status of farm households in Oru East LGA during post-planting season.

Food security status was estimated as the two-thirds of the mean per capita monthly food expenditure of all farm households. The farm households were classified into either food secure or food insecure households based on the food security line. A food insecure household is that whose per capita monthly food expenditure falls below two-thirds of the mean monthly per capita food expenditure while a food secure household is that whose per capita monthly food expenditure is above or is equal to two-thirds of the mean per capita food expenditure (Sulaiman *et al.,* 2015).

Adopting the method of estimation of the Foster, Greer and Thorbecke poverty index, the food security index was estimated as:

$$P\alpha = \frac{1}{N}\sum_{i=1}^{q}\left(\frac{z-Yi}{z}\right)^{\alpha} \ldots \qquad (1)$$

Where:
$P\alpha$ = Food security index
z = Food security line (2/3 mean per-capita household food expenditure)
yi = Per capita household food expenditure (i = 1, 2 ....q);
N = Total number of farm households;
q = Number of food insecure farm households;
α = is the aversion parameter that takes values of 0, 1 or 2 that is $\alpha \geq 0$

When $\alpha = 0$, the FGT index P_0 measures food insecurity incidence. This represents proportion of the farm households that are food insecure i.e. the proportion of farm households that fall below the food security threshold (line). When $\alpha = 1$, the FGT index P_1 measures food insecurity depth of the farm households. This denotes the proportion of food security line that the food insecure farm household require to get out of food insecurity. When $\alpha = 2$, the FGT index P_2 measures the severity of food insecurity status. It measures how far away the food insecure households are from the food security line.

The probit regression model is considered appropriate when dependent variable (Y) takes one of only two possible values representing presence or absence; the model was adopted as used by Gujarati (2003):
Pi [y=1] = [Fzi] … (2)

Where
$Zi = \beta 0 + \beta_1 X_1 + e$
$Y_i = \beta_1 + \beta_2 X_{2i} + \ldots\ldots + \beta_k X_{ki} + \mu$
Yi^* is unobserved but $Yi = 0$ if $y_i^* < 0$,1 if $Y_i^* \geq 0$
$P(Yi = 1) = P(Yi^* \geq 0)$
$P(\mu\, i \geq -\beta_1 + \beta_2 X_{2i} \ldots\ldots\ldots\ldots\ldots -B_k X_{kL}$…(4)

Where i = 1, ……………84
Where Y_i = Food insecurity status of farm households (food insecure = 1, food secure = 0)
β_1 = Unknown coefficients value of factors
X_1 = Age of household head (years); X_2 = Gender of household head (male = 1; female = 0); X_3= Extension access (number of contact); X_4= Level of education (years); X_5 = Amount of credit accessed (Naira); X_6= Farm income (Naira); X_7 = Monthly expenditure (Naira); X_8 = Household size (Number); X_9 = Farming status (full time = 1; part time = 0); X_{10} = Membership of cooperative (1 if member; 0 if otherwise); X_{11} = Remittances (Naira) and X_{12} = Off farm income (Naira).

Results and Discussion

Table 1 shows distribution of the farm households according to socio-economic characteristics. The table shows that mean age of the heads of the farm households was 49 years. This indicates that the heads of the farm households were still active adults capable of withstanding the physical labour and stress associated with farming. The farm households had mean farm size of 0.84 hectares. Farm size is positively associated with the amount of crops grown (Musinguzi, 2000). The larger the farm size of a household, the higher the expected level of food production. Table 1 also shows that the farm households had mean household size of 6 persons. This is good because in face of labour scarcity household members could help in works in the farm enterprise reducing cost of hired labour and increasing farm productivity. However, according to Sikwela (2008) household size has a serious implication on food security and large households have higher propensity of being food insecure. The farm households posted mean annual farm income and non-farm income of 209,520.08 Naira and 122,163.57 Naira respectively. The incomes households earn have positive implications on their adoption of innovations, welfare and economic access to food. The value of food consumed monthly by the farm households was 17337.78 Naira.

Table 1: Distribution of the farm households based on socio-economic characteristics

Variables	Mean
Age (years)	49.26
Farm size (Hectares)	0.84
Household size (number of persons)	6.38
Annual farm income (Naira)	209,520.08
Annual non-farm income (Naira)	122,163.57
Household monthly expenditure on food	17337.78

Source: Field survey, 2017

Estimates of indices of food insecurity in the observed farm households in Oru East LGA during post planting season are shown in Table 2. The food insecurity line defined as two-thirds of the mean per capita food expenditure of the total households stood at 1811.68 Naira. This implies that a farm household whose per-capita food expenditure was below 1811.68 Naira was classified as food insecure while a farm household whose per-capita expenditure equalled or was above this amount was classified as food secure. The degree of food insecurity in Oru East LGA was assessed using the three food insecurity indices: incidence of food insecurity (P_0), depth of food insecurity (P_1), and severity of food insecurity (P_2), following the Foster, Greer and Thorbecke poverty measure. The food insecurity incidence showed that 46.6% of the farm households were food insecure, while the food insecurity gap which measures the extent by which food insecure households were below the food insecurity line was 0.338. This implies that on the average, a food insecure household will require additional per capita food expenditure of 757.28 Naira to exit food insecurity. The value of food insecurity severity was 0.291, implying that there was 29.10% inequality among the food insecure farm households. These estimates are comparable to food insecurity estimates obtained by Egbeogu (2016) in Abia State, Nigeria.

Table 2: Computed food security indices of the farm households

Food security indices	Farm Households
Mean monthly household food expenditure	17337.78
Mean per capita household food expenditure (MPCHHFE)	2717.52
Food security line (2/3 of MPCHHFE)	1811.68
P_0 (Incidence of food insecurity)	0.466
P_1 (Gap or depth of food insecurity)	0.418
P_2 (Severity of food insecurity)	0.291

Source**:** Field survey, 2017

The estimates of the probit regression model which was used to determine factors that influenced food insecurity status of farm households in Oru East LGA of Imo State, Nigeria is presented in Table 3. The model posted a log likelihood value of -87.270, Mcfadden R^2 value of 0.772 and a goodness of fit LR statistic value of 51.615 which was statistically significant at 1.0% alpha level. Seven factors (gender of household head, level of education, amount of credit accessed, farm income, household size, remittances, and off-farm income were revealed to be significant determinants of food security status of the farm households during post-planting season.
The most significant ($P < 0.01$) of the seven factors that determined food insecurity of farm households during post-planting season were level of education (-0.845) and off-farm income (-1.389). The coefficients of both variables were negatively signed, implying that the higher the level of education and off-farm income, the lesser the probability of a farm household being food insecure during post-planting season. Higher education level impacts positively on farmers' productivity and ability to secure higher off-farm income, which invariably increases household food security status. This finding is in agreement with results obtained by Ayantoye *et al.* (2011) among rural households in South Western Nigeria.

The coefficients of gender of household head (-0.054) and amount of credit accessed (-1.00E-05) were significant at $P < 0.05$, implying that male headed farm households that accessed higher amount of credit had relatively lower probability of been food insecure during post-planting season. This finding is understandable because male heads of farm households have relatively better access to land, credit and extension services with which to boost farm productivity, income and household welfare. Nwachukwu *et al.* (2014) and Osei *et al.* (2013) had earlier found that having male head and access to credit reduced food insecurity among farm households. Farm income (0.618) and household size (0.711) posted variedly signed coefficients that were significant at $P < 0.05$. This implies that an increase in farm income decreased the probability of a household being food insecure, while an increase in household size increased the probability of a household being food secure. All things equal, farm households with higher farm income can afford to buy relatively more food items when their barns run short, while, increasing household size means more mouth to feed and lower per capita consumption. The finding agrees succintly with result obtained by Abu and Soom (2016) among farm households in Benue State, Nigeria but disagrees with finding of Emerole *et al.* (2014) in Abia State, Nigeria.

The coefficient of remittances (-0.806) was significant at $P < 0.10$. The negative sign of the variable suggests inverse effect on household food insecurity. This could be attributed to the fact that remittances increase household gross income and could lead to increased per capita income and per capita food expenditure.

Table 3: Probit regression estimates of factors influencing food insecurity status of farm households

Variables	coefficients	Standard errors	Z-statistic	Prob.
Constant	-2.355	2.142	-1.099	0.272
Age of household head	-0.514	0.798	-0.645	0.519
Gender of household head	-0.054**	0.026	-2.078	0.0377
Extension access	0.014	0.148	0.097	0.923
Level of education	-0.845***	0.297	-2.842	0.005
Amount of credit accessed	-1.00E-05**	4.47E-06	-2.242	0.025
Farm income	0.618**	0.313	2.117	0.028
Monthly expenditure	-0.085	0.131	-0.645	0.517
Household size	0.711**	0.312	2.278	0.023
Farming status	0.362	0.715	0.505	0.613
Membership of cooperative	-0.021	0.322	-0.066	0.947
Remittances	-0.806*	0.433	-1.862	0.063
Off-farm income	-1.389***	0.489	-2.841	0.005
Log likelihood	-87.270			
LR statistic	51.615			
Prob (LR statistic)	0.000			
McFadden R^2	0.772			

Source: Field Survey, 2017.
***, **, * Significant at 1.0%, 5.0% and 10.0% alpha levels respectively

Conclusion

This study assessed food security status of farm households during post-planting season in Oru East LGA of Imo state. The study showed that 46.60% of the farm households in the area were food insecure during post-planting period. The study also identified key determinants of food insecurity as gender, level of education, amount of credit accessed, farm income, household size, remittances, and off-farm income. Based on results of the study the following recommendations suffice: Efforts to improve access to credit by farm households and the promotion of off-farm activities as alternative livelihood options should be pursued by both the local and state governments. Female headed farm households should be targeted more in future food security programmes. There should be intensification of enlightenment programmes and campaign on family planning directed at farm households, in order to educate them on the benefits of manageable small household size.

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Evaluation of Micro-Credit Sources, Interest Rates and Adequacy of Credit Advanced to Farmers in Edo State: Implications for Enhancing Food Security and Livelihoods in Nigeria

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Abstract
The study examines sources of micro-credit, interest rates and adequacy of credit advanced to arable crop farmers in Edo State, Nigeria. Multi stage random sampling procedure was used in selecting 150 arable crop farmers in the study area. Data were collected with the pre-tested questionnaire and analyzed using descriptive techniques such as mean, frequency distribution, percentages and t- test statistic. The study revealed that micro-credit lending from friends attracted interest rates ranging from 2% to 5%. Credit from family members did not attract any interest rate. Osusu charged interest rates that ranged from 2% to 3%, while Micro-finance Banks charged between 5% to 9% interest. Co-operative societies charged interest rates of between 2% and 3% while Commercial Banks charged the highest interest rate of between 20% and 24% on micro-credit. With the exception of commercial banks whose micro-credit term may extend up to 24 months all others had 12 months. Shortness of repayment time and selling off farm products even when prices are low in order to repay loan are the major problems facing farmers in acquiring and managing credit obtained. The study recommends the need to shore up the capital base of informal credit providers to improve their capacity to disburse high loan sums to farmers. This is expected to improve farmer's ability to generate high annual turnover and hence break the vicious cycle of poverty. International agencies targeting poverty alleviation among rural populace can channel such assistance through informal micro-credit providers. Attempt should be made by micro-credit providers to extend the loan term from 12 months to 2 years as it would give farmers sufficient time to sell their farm products off at remunerative prices. Effort should also be made by farmers in efficiently utilizing credit so as to boost their productivity and income as it will go a long way to improve their loan repayment performance and hence livelihood.

Keywords: *Micro-credit, farmers, credit, interest rate, arable crops*

Introduction
The efforts of government towards mobilizing and supporting the agricultural sector of the economy so as to improve standards of living of the farmers are more pronounced now than ever. This is against the increasing awareness that the farmers are capable and willing to pull themselves out of poverty if a conscious effort is made to ease their access to credit. This will increase the level of farm output / income thereby solving the problems of production, consumption and nutrition among farmers. The accessibility of a good financial service is considered as one of the engines of economic development. Governments of less developed countries have frequently practiced the policy of providing cheap credit to the agricultural sector through financial intermediaries. This cheap credit, it was hoped, would lower the dependence on the rural money lenders (Pinaki, 1998). The provision of credit has increasingly been regarded as an important tool for raising the incomes of rural populations, mainly by mobilizing resources for more productive uses. As development takes place, one question that arises is the extent to which credit can be offered to the rural poor farmers to facilitate their farm operations, all things being equal. Thus, the usefulness of any

agricultural credit programme does not only depend on its availability, accessibility and affordability but also on its proper and efficient allocation and utilization for the intended purpose by beneficiaries (Oboh, 2008). However, credit diversion, poor repayment rate and loan default among farmers continue to be a challenge. The extent, to which this is true among arable crop farmers in Edo State in terms of rate of credit allocation to the farm sector and the factors affecting it, is not known.

A number of researches have attempted to explain the factors affecting credit accessibility by farmers in Edo State (Izekor and Alufohai, 2010; Alufohai, 2006; Alufohai and Ahmadu, 2005). Also, Asekome and Ogbechie (2011) posited that credit is not easily accessible and if accessible from moneylenders, they charge rates too high for micro enterprises to pay. The high rates contribute to the cost of capital and further negatively impacts on the annual turnover of the farm enterprise. Asekome and Ogbechie (2011) further posited that farmers buy inputs at exorbitant rates because they cannot buy in wholesale markets, thereby reducing their profit margins. According to Ikhelowa (2011), the foregoing underscores the need to make adequate loanable fund available to farmers at the right time and at such rate that will make returns on investment more attractive. But, there is lack of clarity on the relationship between the volume of loan received and farmers' annual turnover among arable crop farmers in Edo State. Despite the centrality of micro-credit for investment in farm enterprise, Ikhelowa (2011) asserted that banks are often very reluctant to give loans to farmers because of the risky nature of agricultural enterprises. This is due to many unforeseen and uncontrollable factors like weather problems, flood, pests and diseases. The irreversibility of investment made in agricultural enterprise may have reinforced the reluctance of banks to give credit to farmers. According to Onietan and Afolayan (2010), the foregoing factor is closely connected to the biological nature of agricultural sector which includes long gestation period, seasonality of production and perishability of raw products.
Past studies by scholars, including Umoh (1981), Idachaba (1985) and Ikhelowa (2011) stressed that commercial banks do not respond adequately to the needs of the farmers especially the small – scale farmers. The poor responses include delayed processing of application, lack of or poor supervision of funded projects, inadequate amount of money compared to the requirements of the farmers (Ikhelowa, 2011). Hence the choice of micro-credit sources by farmers which include traditional savings associations, cooperative societies, micro finance banks, friends, family and relations (Osagie, 2006). But the interest rates, adequacy and timeliness of the different sources of micro-credit patronized by arable crop farmers are not known.

This study analyzes the sources of micro-credit, ascertains the interest rates, adequacy and timeliness of the different sources of micro-credit patronized by the arable crop farmers. It also examines the problems associated with the different sources of micro-credit delivery for arable crop farmers and proffer solutions. A study of this nature will assist farmers in realizing their potentials for increasing output and incomes. Secondly, it will show the adequacy and timeliness of micro–credit intermediaries both formal and informal and help to strengthen their operations. Thirdly, international donors and financiers will be provided local information in order to maximize existing facilities.

Methodology

The study was conducted in Edo State, Nigeria. It lies roughly between longitudes 05° 04′E and 06° 43′E and latitudes 05° 44′N and 07° 34′N. The state had a population of 2,159,848 (National Population Commission 2007) and made up of 18 Local Government Areas (LGAs) grouped into three agricultural zones. The climate of Edo State is equatorial in nature. It is characterized by humid conditions in the southern parts and sub-humid conditions in the northern parts (Okoro, 2002). The rainfall pattern, which is bimodal, varies from 200cm a year in the southern part to 115cm a year in the north spanning about eight months of the year (Azeke, 2002). The temperature is about 27°C on the average with a monthly range of 22°C to 35°C and relative humidity of 79% to 90%. The vegetation zones distinguished the agricultural zone.

Three Local Government Areas (LGAs) were purposively selected from each of the 3 agricultural zones of the state. In each LGA, two communities were randomly selected. A sample frame consisting of the names of the farmers was obtained from the extension agents. A simple random sampling technique was used in selecting eight (8) respondents among the identified arable crop

farmers in each of the selected communities in Edo north and Edo central. In Edo south, nine (9) arable crop farmers were randomly selected. This brought the sample size of the study to one hundred and fifty (150) respondents. A pre tested structured questionnaire that elicited information on micro-credit sources, interest rates, loan term, timeliness and adequacy of loans obtained as well as constraints facing crop farmers in obtaining loans was used for the study. Data were analyzed using frequency descriptive techniques such as mean, frequency distribution and percentages, as well as other appropriate statistical tools such as t-test statistic.
Comparison of differences in the means between amount of micro-credit applied for and amount obtained from the different sources was facilitated using t-test statistics for independent samples. The t-test statistic is given as:

$$t = \frac{X_1 - X_2}{SE^2{}_1 + SE^2{}_2}$$

Where:
$\bar{X}$ = Means of 2 independent samples
SE^2 = Standard errors
S^2 = Sample Variance

Results and Discussion

Table 1 shows micro-credit sources, interest rates and loan term. In this table, micro-credit lending from friends attracted interest rates ranging from 2% to 5% with a loan term of 12 months. Micro-credit from family members did not attract any interest rate. While Osusu charged interest rates that ranged from 2% to 3%. Micro-finance Banks charged between 5% - 9%. Co-operative societies charged interest rates of between 2% and 3% while Commercial Banks charged the highest interest rate of between 20% and 25% on micro-credit. The interest rate charged on micro-credit from the different sources depends to a large extent on the relationship between the borrower and the lender. This accounts for why people obtain loan from the same source at different interest rates. With the exception of commercial banks whose micro-credit term may extend up to 24 months, all others had 12 months. Short micro-credit term may pose repayment problems for arable crop farmers. To this end, Aligbe (2016) suggests an extension of micro-credit term from 12 to 24 months.

Table 1: Micro-Credit Sources, Interest Rates and Loan Term

Sources of Micro-credit	**Interest Range (%)**	**Loan Term**
Friends	**2-5**	12 months
Family /Relations Contribution	Nil	12 months
Osusu	2-3	12 months
Micro-finance Banks	2-3	12 months
Co-operative Societies	5-9	12 months
Commercial Banks	20-25	12-24 months

Source: Field Survey, 2013

In determining the adequacy of micro-credit received by arable crop farmers, the means of the amounts applied for and the amounts obtained were compared. Results obtained in Table 2, shows that in all the sources, farmers got lower amounts of micro-credit than the amounts they applied for. The difference in means as revealed by the t-test result is statistically significant at the 1% level of probability. This implies that the amount of loan applied for from all the sources within the period covered by the study is significantly greater than the amount obtained and therefore inadequate to meet the needs.

Table 2: Difference in the Means between Amount of Micro-Credit Applied For and Amount Obtained from the Different Sources

Statistics	Osusu	Co-operatives	Micro-Finance Banks	Family Contribution	Friends	Commercial Banks
Amount Applied (₦)	80056.33	73000.00	81655.17	93750.00	114545.45	246428.57
Std. Dev.	30883.13	26886.33	15710.04	31481.28	34165.37	49862.44
Df.	70	16	28	7	10	13
T-value.	21.843*	11.195*	27.990*	8.423*	11.120*	18.492*
Amount Received (₦)	72014.08	71647.05	71586.20	76250.00	100000.00	226428.57
Std. Dev.	19528.36	17765.63	14814.36	26692.69	26267.85	83261.14
Df.	70	16	28	7	10	13
T-value.	31.073*	16.628*	26.022*	8.080*	12.626*	10.175*

Source: Computed from survey data, 2013
Note: *Significant at P≤ 0.01

Farmer's perception of problems associated with various sources of micro-credit is presented in Table 3. Majority of the farmers (66) are of the opinion that the one year duration of the loan is too short. They opined that an additional 12 months would suffice them to harvest their crops and sell them at good prices rather than sell them at harvest. This is closely followed by those respondents (60) who were of the opinion that they were forced to sell farm products even when prices were not encouraging in order to repay loan. This phenomenon makes most farmers' to forfeit good prices if their farm products were sold at a time there was no glut (off season). The implication of flooding the market with farm products at harvest is that there will be food scarcity at off-seasons with prohibitive prices. This has serious consequences for national food security. Moreover, selling farm products at poor prices at harvest will limit the amount of income generated from farming, standard of living and ability to invest. This phenomenon could aggravate the poverty status of farmers. Fifty respondents were of the opinion that the loan amount obtained was inadequate to carry out their farming activities the way they would have preferred. This is because in almost all instances, the amount of micro-credit applied for was lower than that approved. The implication of this result is that business expansion and growth is thwarted with no respect for progress. This may pose serious problems for agricultural development and food security. Twenty-eight respondents were of the opinion that high interest rate and surcharge on repayment default constitute constraints of borrowing from the various sources. It is the attempt at avoiding the payment of surcharge upon default of repayment that may have driven most of the respondents to sell their farm products immediately after harvest at poor prices. This calls for the extension of loan term from 12 to 24 months.

Table 3: Farmer's Perception of Problems Associated with Different Sources of Micro – Credit

Problem	Friends/ Relations	Family contributions	Osusu	Microfinance Banks	Cooperative societies	Commercial Banks	Total
Short loan term	6.06%	3.03%	46.96%	25.7%	18.2%	-	66
Inadequate loan amount	16%	8%	40%	36%	-	-	50
High interest rate	12.5%	5%	30%	22.5%	-	30%	40
Sur – charge on repayment default				35.7%	28.6%	35.7%	28
Forced to sell farm products even when price is not encouraging in order to repay loan	-	-	-21.7%	41.66%	23.3%	13.3%	60

Source: Field Survey, 2013

Conclusion and Recommendations

Even though interest rate from the various micro-credit sources is moderate and loan is disbursed on time, the loan amount obtained by arable crop farmers from micro-credit providers is inadequate to meet their production needs. This suggests that with higher loan sums, farmers have the potential for generating higher annual turnover. The study recommends the need to shore up the capital base of informal credit providers to improve their capacity to disburse high loan sums to farmers. This is expected to improve farmer's ability to generate high annual turnover and hence break the vicious cycle of poverty. International agencies targeting poverty alleviation among rural populace can channel such assistance through informal micro-credit providers. The performance of the informal micro-credit sub-sector as it presently stands cannot be relied upon to achieve these objectives. This calls for urgent and pragmatic steps to be taken to improve the systems performance. It is imperative to grant farmers the required amounts of loan to enhance their loan repayment performance. There is an urgent need for increase in the rate of agricultural credit allocation to the farm sector to ensure increased productivity of crops grown for increased welfare and livelihood of these farmers and the citizens of the State as a whole. Attempt should be made by micro-credit providers to extend the loan term from 12 months to 2 years as it would give farmers sufficient time to sell their farm products off at remunerative prices. Effort should also be made by farmers in efficiently utilizing credit so as to boost their productivity and income as it will go a long way to improve their loan repayment performance and hence livelihood.

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Social Diversity among Cassava Producing and Processing Communities in Imo State

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Abstract
This study investigated social diversity among cassava producing and processing communities in Imo State with a view to describing the sources of diversity and identifying differences between communities. A purposive and multi-stage sampling technique was used in selecting a sample size of 240 respondents consisting of 20 cassava farmers/processors (10 males, 10 females) from each of 12 communities namely Logara, Umuohiagu, Egbeada-Ubomiri, Ihite-Isi-Mbieri (Owerri Zone), Abba, Umunakara, Umueze-anoruo, Eziama-obaire (Orlu Zone), Amuro, Isieke-agbaogwu, Mbara-okwe and Okeohia (Okigwe Zone). Data was elicited using semi-structured pre-tested questionnaire. Descriptive statistics such as mean, percentage, and frequency distribution; and analysis of variance (ANOVA) were used to analyze the data. Results from this study showed that there were significant differences (P<0.05) among communities in some socioeconomic attributes including Age, Education, Marital status, and Income from cassava business implying that the communities were socially diverse with respect to these attributes. New and extant policies should be tailored towards mitigating the gaps amongst communities covered in the study.
Keywords: Socioeconomic attributes, Cassava farmers, Age, Education, Marital status, Income

Introduction
Cassava (*Manihot esculenta* Crantz*)* is an important staple food and cash crop in several tropical African countries especially Nigeria where it plays a principal role in the food economy (Agwu and Anyaeche, 2007). Wide adoption of high-yielding cassava varieties, better pest management and value addition technologies have resulted in a sharp rise in its production, processing and consumption.

Social diversity refers to differences between categories of people in their access to and control over livelihood assets, relative wealth, livelihood security, social status, and sense of belonging to different social groups and cultural norms and beliefs (FAO, 2011). Diversity describes differences in age, gender, language, values, attitudes, cultural perspectives, beliefs, nationality, ethnic background, sexual orientation, abilities, impairments, skills, knowledge, level of education, life experience, to be found in a group of people. While the age and gender dimensions are present in everyone, other characteristics vary from person to person and context to context (GICHD, 2014). Stine, (2017), posits that social differentiation is common to most facets of human social life. Social stratification, the systematic ranking of categories of people, especially in their access to livelihood and power is, both "pernicious" and "pervasive". Categories become imbued with specific, negotiated cultural meanings, and as such, become powerful forces in social life. Sources of social diversity include age, sex, religion, culture, ethnicity, disability, castes, poverty which influence the delivery and impact of development programs to improve livelihood and income of farmers involved in the production of crops like cassava.

There is also lack for data on social diversity which could help in understanding differences and influence of diverse groups, contributions and challenges faced by diverse groups in cassava production and processing. In addition, there are poor planning, monitoring and evaluating development programmes targeted at different social groups to increase productivity due to scarcity of necessary social diversity specific data. This scarcity of empirical data on social diversity necessitated this study on social diversity analysis among cassava root producing and processing farmers in Imo state Nigeria.

Methodology

The study was carried out in Imo State of Nigeria. The state lies within latitudes 4°45'N and 7°15'N of the Equator and longitudes 6°50'E and 7°25'E of the Greenish Meridian with an area of 5,100 sq km. The state has a population density of 712 persons per square kilometer (NPC, 2006). The language spoken in Imo State is Igbo though as part of Nigeria, English is the official language. Culturally Ibos of Imo State operates a patriarchy i.e. systemic societal structures that institutionalize male physical, social and economic power over women.. A purposive and multi-stage sampling technique was used in selecting a sample size of two hundred and forty (240) respondents consisting of 20 cassava farmers/processors (10 males, 10 females) from each of 12 communities namely Logara, Umuohiagu, Egbeada-Ubomiri, Ihite-Isi-Mbieri (Owerri Zone), Abba, Umunakara, Umueze-anoruo, Eziama-obaire (Orlu Zone), Amuro, Isieke-agbaogwu, Mbara-okwe and Okeohia (Okigwe Zone). Data was elicited using a pre-tested semi-structured questionnaire. The primary data gathered included socio-economic attributes like age, education, occupation, marital status, income from cassava business and membership of cooperative societies. Descriptive statistics such as mean, percentage, and frequency distribution; and analysis of variance (ANOVA) were used to analyze the data.

Results and Discussion

Sources of Social Diversity among Cassava Producers and Processors in Imo State

The distribution of male and female cassava producers and processors in Imo state Nigeria according to their socioeconomic attributes is presented in Table 1. Respondents can be stratified into young (<20-29 years), middle aged (30-59 years) and aged (>60 years). 75.85% of the male and 79.16% of female respondents was middle aged. Age is an important source of social diversity as it creates differences in perceptions and abilities which influence the delivery and impact of development programs to improve livelihood and income of farmers involved in the production and processing of crops like cassava in the study area. Further subdivisions into age grades are also prevalent in Imo and other south eastern states. Age grades champion social, cultural, political, infrastructural and economic development of communities. Age grades contribute towards the development of their communities through communal labour, constructing and maintaining roads, building bridges, providing portable water and among other efforts protect their communities from military attacks or invasions from their neighboring communities (Okodo, 2012). Communal labour, good local roads and security provided by age groups are incentives for cassava production and processing.

Result shows that most (97.0% of males and 95.5% of females) of the respondents were literate at various levels with only a small proportion (3.0% for males and 5.0% for females) having no formal education. Level of education forms a milieu which stratifies a community into socially diverse groups with different abilities which affects their probability and intensity of participation in cassava production and processing. Table 1 also show that 72.5% of males and 65.8% of females did not go beyond secondary school. This excludes them from the membership and mentorship of graduate associations within their communities. These associations are known to wield some influence which affects agricultural production and processing in their communities. FAO, (2011), and GICHD, (2014) reports that level of education varies from person to person and context to context and influences people in their access to and control of livelihood assets, relative wealth, livelihood security, social status, sense of belonging to different social groups.

Distribution of respondents according to their occupation is shown in Table 1. In addition to farming for which they were purposively selected, 18% of both male and female respondents were government workers. A slightly higher percentage of females (8.0%) compared to males (4.0%) were traders. Adebayo *et al*, (2016) reported an almost similar percentage of civil servants amongst the respondents in their study in Ibarapa area of Oyo State. This result supports the growing tendency of public servants to engage in agricultural activities especially in the Southeast of Nigeria where workers salaries are not paid regularly. Farming is a common option for workers who seek to genuinely diversify their sources of income amidst uncertainties associated with wages in the Nigerian contest. Occupation also provides a means of stratifying a people and therefore is a source of social diversity. Some occupations wield more influence and social recognition while some are looked upon with disdain. During the oil boom era, cassava was seen as a woman crop (Okorji, 1983) and its cultivation and processing looked upon with disdain. But these perceptions are changing now as cassava is becoming an important source of cash and not just a staple food.

The distribution of respondents according to their marital status is also presented in Table 1. The results presented show that majority (74.0% males and 77.0% females) were married. The preponderance of the married people could create potential for increased farm labour supply which would contribute positively to cassava production and processing. However, 12.5% of the female respondents were widows. This implies that women tend to work harder when their husbands are no more, so this group sees cassava production and processing as a viable venture that could provide for their families. Oni, (2016) also found that majority (87.0%) of those involved in Cassava production were married. Amadi *et al*, (2016) observed that the married class does have access to extra financial, moral and physical supports from their spouses that could go a long way to improve their production activities. Furthermore, Nze *et al*., (2017) reasoned that married women engaged themselves in cassava production and processing in other to utilize the different end products of cassava which can serve for both household and commercial uses. Emerole, *et al*., (2014) argued that majority of cassava entrepreneurs being married suggest that activities involved in the enterprise generates attractive returns enough to help households cushion effects of food and financial insecurity associated with married life. Marital status is a significant source of social diversity as it may lead to social inclusion or exclusion in societal groupings. Marriage comes with responsibility and social expectation which influences participation in agricultural activities including cassava production and processing. Married people are obligated to provide food for their homes and the most common way to do that is by engaging in agricultural activities like cassava production and processing. However, 12.5% of the female respondents were widows. Widows are a disadvantaged group especially in patricidal societies like Imo State because many are disinherited of assets belonging to their husbands and are subjected to different forms of social exclusion.

Table 1 also shows the distribution of respondents according to their monthly income from cassava business. From data presented in the table, it is evident that most of the respondents (66.63% males and 63.32% females) earned between ₦ 10,000 – ₦ 50,000 monthly. The mean monthly earnings for males (₦44, 445.83) and females (₦44, 410.00) were similar. Okpara, (2015) reported that men earned more income than females from cassava processing in Enugu State. Damisa *et al*., (2007) theorized that the higher the level of income, the greater is the level of participation of the woman in agricultural production. More income would be made to her disposal to meet her technical and logistic needs in production. Income provides a mean of stratifying people into rich and poor; lower, middle and upper class with different influences and opportunities in the society.

Distribution of respondents according to their membership of cooperative societies is shown in Table 1. Only 20.0% males and 18.0% females belonged to cooperative societies indicating that majority of the respondents did not. This finding is consistent with the report of Onyemauwa, (2012) which showed that about 72.0% of the respondents do not belong to, and take part in, cooperative activities. Incidentally, most agricultural technologies are provided to farmers who belong and take part in cooperative activities. Their non participation in cooperative activities will likely constrain their production and processing activities. In spite of the availability of cooperative societies and efforts of government and Non-Governmental Organizations (NGO's) at various levels to support these organizations, it appears that a significant proportion of rural farmers are either unaware of the existence of such co-operative societies or are lacking in the basic socioeconomic characteristics that form the prerequisite for participation in such activities (Idrisa *et al*., 2007). Farmers communicate most frequently and effectively with those who are most similar to them. These farmers are more likely to obtain information from and be influenced in their farming practices and adoption decision by other farmers (Murphy, 1993; Bamire *et al*., 2002; Tahirou *et al*., 2015). The respondents who are non members may be missing out on the many advantages of belonging to cooperative societies including increasing member's production and incomes by helping better link up with finance, agricultural inputs, information, and output markets (EATA, 2012; FAO, 2012; Tahirou *et al*., 2015).

Table 1: Distribution of male and female Respondents according to sources of social diversity

Socioeconomic characteristics	Male		Female	
Age (yrs)	**Frequency**	**Percent**	**Frequency**	**Percent**
Young (<20-29)	20	16.66	15	12.48
Middle Aged (30-59)	91	75.85	95	79.16
Old (>60)	9	7.49	10	8.36
Education				
Illiterate	4	3.35	6	5
Primary	40	33.33	28	23.34
Secondary	43	35.83	45	37.51
University	29	24.17	26	21.67
Post graduate	4	3.32	15	12.48
Occupation				
Farming	120	70.95	120	68.97
Civil/Public servant	27	17.46	32	18.39
Trading	7	4.27	14	8.05
Corporate work	2	1.22	1	0.57
Artisans/Others	8	4.88	7	4.02
Marital status				
Single	22	18.33	12	10.00
Married	89	74.17	92	76.67
Widowed	9	7.50	15	12.50
Separated	0	0.00	1	0.83
Income from Cassava business (₦)				
< 10,000	6	5.08	5	4.17
10,000 – 50,000	80	66.63	76	63.36
50,000 – 100,000	23	19.14	32	26.64
> 100,000	11	9.15	7	5.83
Membership of Coop Societies				
Yes	24	20.00	22	18.33
No	96	80.00	98	81.67

Source: Field Survey Data 2017.

Differentials in respondents' socioeconomic attributes among selected communities in the study area

The mean values of different socioeconomic attributes of the respondents according to communities are presented in Table 2. Significant differences (P<0.05) were observed amongst communities in some attributes implying that the communities were socially diverse with respect to these attributes. The mean age of respondents from Isieke agbaogwu was significantly higher than that of respondents from Egbeada-Ubomiri while mean ages of respondents from other communities were similar. Respondents from Abba and Egbeada-Ubomiri spent more years in school compared to those from Okeohia, Umuohiagu, Umueze-Anoruo, Umunakara and Mbara-okwe. Most of the respondents were either married or widowed but there were more married or widowed respondents in Umunakara, Isieke agbaogwu and Okeohia compared to Ihite Isi Mbieri, Abba, Umuohiagu and Egbeada-Ubomiri. Respondents from Logara earned more from Cassava business compared with those from other communities. Those from Isieke agbaogwu earned the least but did not differ significantly (P<0.05) from those from 7 other communities. The trend for membership of cooperative societies was similar for most communities as most respondents did not belong. At Okeohia, all respondents were not members of any cooperative society.

Table 2: Differentials in respondents' socioeconomic attributes among selected communities in the study area

	Socioeconomic attributes				
Communities	**Age**	**Education**	**Marital Status**	**Monthly Income**	**Membership Cooperatives**
Okigwe Zone					
Amuro	40.35	11	2	18,950	1.9
Isieke agbaogwu	44	11.55	2.15	15,900	1.65
Mbara-Okwe	42.4	7.95	2.1	39,050	1.9
Okeohia	42.2	10.2	2.15	47,525	2
Orlu Zone					
Abba	37.5	14.1	1.75	26,640	1.8
Eziama -obaire	42.45	11.5	2.05	59,560	1.9
Umueze -Anoruo	43.15	9.05	1.9	44,810	1.8
Umunakara	43.05	8.45	2.4	23,100	1.75
Owerri Zone					
Egbeada-Ubomiri	36.45	13.45	1.7	17,800	1.7
Ihite Isi Mbieri	37.1	11.3	1.75	28,600	1.85
Logara	42.35	11.9	1.9	90,350	1.75
Umuohiagu	40.5	9.8	1.75	36,800	1.7
LSD 0.05	7.45	3.1	0.29	26,205.00	0.24

Source: Field survey, 2017

Conclusions and Recommendation

This study investigated the social diversity amongst cassava producers and processors in Imo State, Nigeria with a view to describing the sources of diversity and identifying differences between communities. Findings from the study showed that Social diversity was evident between some communities in some attributes such as age, educational level, marital status, and monthly income from cassava business. Significant diversity between communities was evident in most of the attributes. In line with the finding of this study it recommended that new and extant policies should be tailored towards mitigating the diversity gaps amongst communities covered in the study.

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Effects of Climate Change on the Livelihood of Farmers in Oluyole Local Government Area of Oyo State Nigeria

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Abstract
The study aimed to examine the effects of climate change on the livelihood of farmers in Oluyole Local Government area of Oyo state. The objectives of this work was to determine the socio-economic characteristics, source of income of the farmers, determine the level of awareness of climate change and the effects of climate change on health of the farmers. The study used primary data through a well-structured questionnaire and scheduled interview, fifty respondents were randomly sampled. The use of frequency count and simple percentage were used to analyze the data. The study revealed that the male population makes up 76% of the farmers while female population is 24%. 70% of the farmers are married, 10% are divorced and 20% widowed. The study also indicated that 54% had non-formal education, 20% of the farmers had quranic education while 12% and 8% of the farmers had secondary and tertiary education respectively. It was further revealed that 90% of the forest zone has been degraded as a result of deforestation. Research institute which represents 60% appeared to be the respondents major source of information on climate change, only 30% heard from radio/Television station (TV), none of the farmers got their information through the newspaper. The common ailment is malaria (66%) while headache constitute only 12% of health risk experienced by the respondents. Their major source of water supply during dry season is stream 76%, which is scarce during dry season (68%).The farmers main livelihood activities is trading of forest products (firewood & bush meat-58%) ,sales of farm products and medicinal herbs represent 30% of their source of income. This study recommends more awareness strategies on climate change be opened-up to the farmers to curb the effect of deforestation. Good water supply should be provided in the area to eradicate the effects of prolong drought.

Key words: Climate change, Global warming, deforestation, livelihood

Introduction
Inter-Governmental panel on Climate Change (IPCC 2007) Links it to the changes in global average temperature between (0.74+_ 0.18). The world health organization (WHO) also considers the consequences of global warming as the most pressing problem of the 21st century. The implication of climate change on human health could be direct or indirect. According to Building National Response to Climate Change (BNRCC) the direct consequences of climate change in Nigeria include cerebra-spinal meningitis, cardiovascular respiratory disorder of the elderly, skin cancer, high blood pressure, malaria and cholera. There is much danger to child and maternal health (UNDP, 2005).From ancient times, early naturalists and philosophers theorized on a possible climate change, for instance Theophrastus a pupil of the famous Greek philosopher, Aristotle (384-322BC) speculated that lands became warmer when the clearing of Forest exposed them to sunlight; hence significant changes In global warming are not strange in earth's history. Renaissance scholars including Vitruvius were of the opinion that deforestation, irrigation and grazing had effects on the local weather around the world (Neuman, 1985). Climate change is a complex interaction between earth's atmosphere- stratosphere and troposphere on one hand and land biosphere (Allen, 2004; Solomon et al'2008). Carbon dioxide and other greenhouse gases are generated as waste by products by human activities; this traps heat from escaping from the troposphere thereby causing global warming. Global warming is the term used to describe the gradual increase in the average temperature of earth's atmosphere and its ocean, a change that is permanently changing earth's climate forever. Global warming is caused by increase in the emission of GHGs through the burning

of fossil fuel (oil, natural gas, and coal), burning of wood products and solid wastes, bush burning and deforestation. All these human activities (anthropogenic) contributes to alter the balance of the equilibrium between the natural GHGs (water vapour,CO2, methane and nitrous oxide) and the man-made GHGs (sulfur hexane fluoride-SF6), hydroflourocarbons-HFC and per fluorocarbons-PFC In earth's atmosphere and the ocean since they are heat trapping gases.

Climate change has been found to have several negative consequences cutting across nearly all spheres of life particularly urban livability and human health either directly or indirectly (Aisha and Sasilata ,2016; Malikabood et al,2016 ; Sarry El-Din et al,2012). This follows from its effects on environmental determinants of health such as clean air, effluents discharge from homes and industries, melting glaciers, rising sea levels and their effects on flooding make water unsafe for drinking. Changing rainfall pattern and rising temperatures as well as deforestation impact food production with resulting effects on health. According to the world health organization (WHO) around 250,000 additional deaths are projected to occur annually between the year 2030 and 2050 due to malnutrition, malaria ,diarrhea and heat stress occasioned to climate change (WHO,2015). Deforestation is the removal of a forest or stand of trees where the land is thereafter converted to a non-forest use (dictionary of forestry, 2008). Odjugo, 2010 inferred that for 105years there has been increase in temperature by 1.1oc and decrease in rainfall by 81mm, this was attributed to high rate of deforestation leading to increase in desertification (inyang and Esohe, 2014). Deforestation has been implicated in Flooding cases which affects farm lands leading to food shortages and ultimately the source of livelihood of rural farmers, health risk as also been implicated in flooding resulting in disease such as cholera and diarrhea. There have been reported cases of cholera outbreak in several parts of Nigeria-the south; including Rivers, Cross river states in the Niger Delta (NIMET, 2010) .It is important to note that deforestation activities increase the amount of carbon dioxide released into the atmosphere through wood smoking kiln, firewood burning, charcoal production and forest degradation. All these post deforestation activities release carbon dioxide into the atmosphere thereby contributing to the greenhouse gases consequently causing global warming which is a precursor to climate change with concomitant negative impact such as increase temperature, rise in sea level, flooding, famine, ecosystem collapse and ultimately death. Livelihood refers to means of making a living. People adopt various lifestyle and ways of meeting their needs. Livelihood depends on the availability of various resources, skills, education, socio-economic factors, agro-climate and agro-ecology as well as gender (Akinwale, 2010; Porter et al, 2007). The specific objective of this study is to determine the effect of climate change agents on the livelihood of farmers in Onigambari.

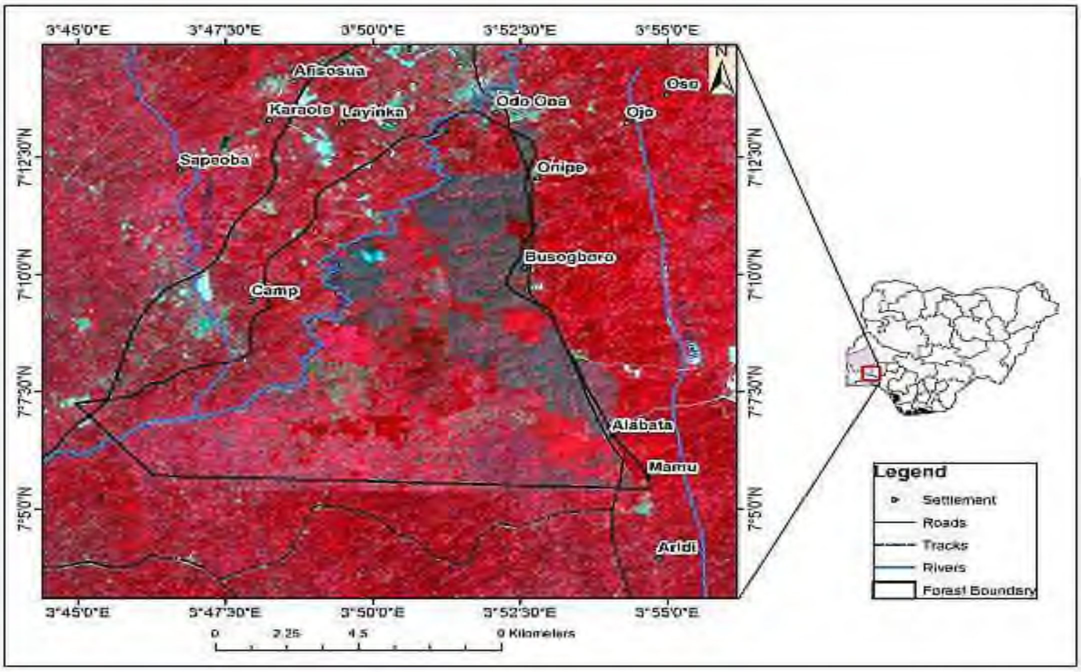

Fig1: Map of Onigambari Forest Reserve.
Source: Field work.

Methodology

Oluyole is a Local Government area in Oyo state, South West Nigeria. It was established in 1976 and occupies a land mass of 4000 square kilometer with a population of 202,725 (Census 2006).The study was conducted around Gambari Forest Reserve, 5 villages which include Odo-ona ,Busogboro, Mamu, Alabata and Onipe where purposively selected. This village was selected based on the high concentration of farmers in the area. Maize, coco –yam, cocoa and cassava are the major crops grown in the area. Questionnaire was randomly administered to 50 farmers out of 102 farmers identified. Frequency and simple percentage method of data analysis was used to examine the test variables and the generated results.

Results and Discussion

Age, gender, marital status, level of education, family size, livelihood activities were the socio-economic parameters analyzed. Tab 1. Revealed that majority of the respondents were male (76%) while only 24% were female. 10% of the farmers are widows, 20% divorced and 70% are married. This is in agreement with the works of Adesiji *et al* (2013), Ojo and Mohammed (2008) who had revealed that 53.1% and 96% respectively of their respondents were married. The implication of this is likely to result in respondents having more children which directly increase the population and other human activities (Anthropogenic). Deforestation, one of the causative factors of climate change is extremely high in this area; this was confirmed by the present study where the rate of forest degradation as a result of deforestation has increased to an alarming rate of (90%) in this area. It was also discovered by the present study that the rural farmers are predominantly illiterate, majority of who had non-formal education 54% as compared to 12% secondary education, 20% had Quranic education, 6% had Adult education, 8% had tertiary education with 0% primary education . This is in agreement with the findings of Ndanitsa. (2005), TSOHO (2005) who separately reported in their studies that rural farmers are characterized with low level of literacy. The study further shows that the main source of income of the farmers is trading of Bush meat and firewood 58%, while sales of medicinal herbs and other farm products represent 30% of the farmer's income source while only 12% utilizes their farm products for personal use .Family size of 5-10 represent 60%of the respondents, 1-4 represents 30% while 10 and above represents 10%.

Tab.2. shows that 86% of the respondents are aware of climate change, only 14% of them are not aware, the table also indicates that 60% of those aware got their information through Research institute while 30%got their information through Radio/TV station. None of the farmers got their information through Newspaper 0%, 6% got their information from Non- government organization (NGO) while 4% heard from farmers association. 90% of the farmers believed that the forest has been degraded as a result of deforestation activities, 10% believed that the forest is still intact.

Tab.3. revealed that malaria is the most common ailment experienced by the farmers 66%, followed by cholera 18% headache 12%, Headache & cholera 2% and typhoid, headache &malaria represents 2%. Result in Tab.4. Shows that the farmer's source of water during dry season is the Stream which account for 76% of their water supply during the dry season, well and borehole water accounts for 12% each. 68% of the farmers said that water was not available during prolong drought /dry season while 32% agreed that water was available during this season.

Table1. Socio-Economic distribution of farmers and their source of income (n=50)

Variables	Frequency	Percentage
Gender		
Male	38	76%
Female	12	24%
Marital Status		
Married	35	70%
Divorced	5	10%
Widowed	10	20%
Age		
20-31	4	8%
31-40	8	16%
41-50	17	34%
51-60	18	36%
61-70	3	6%
Level of Education		
Non-Formal Education	27	54%
Adult Education	3	6%
Quranic Education	10	20%
Pry Education	-	0%
Secondary Education	6	12%
Tertiary Education	4	8%
Family Size		
1-4	15	30%
5-10	30	60%
10 &Above	5	10%
Main livelihood Activity		
Sales Of Medicinal Herbs / Farm Product	15	30%
Trading (Bush Meat/Firewood)	29	58%
Personal Use	6	12%

Source: Field work 2018

Tab2: Farmers sources of information and climate change, awareness and level of deforestation

Source Of Information	Frequency	Percentage
Aware	43	86%
Not aware	7	14%
Research institute	30	60%
Radio/TV station	15	30%
Newspaper	-	0%
Non-govt organization	3	6%
Farmers association	2	4%
Deforestation Rate	Frequency	Percentage
Intact	5	10%
Degraded	45	90%

Source : Field work 2018

Tab.3: Health challenges usually experienced

Ailment	Frequency	Percentage
Cholera	9	18%
Malaria	33	66%
Headache	6	12%
Headache & cholera	1	2%
Typhoid, Headache & Malaria	1	2%

Source : Field work 2018

Tab 4: Source of water during dry season and availability

Sources	Frequency	Percentage
Available	16	32%
Scarce	34	68%
Well	6	12%
Borehole	6	12%
Stream	38	76%

Source : Field work 2018

Conclusion

From the results it is obvious that the farmers are aware of climate change to a high extent, although most of them had non-formal education, they can easily be tutored by research institutes representatives and other agencies. Their main sources of livelihood are trading of forest products and agriculture. The health risk analysis shows that malaria is the prevalent health challenge experienced by the farmers, also acute water shortage is experienced during dry season .Finally the study showed that deforestation is on the increase in the study area. Sequel to this findings and conclusions, it is hereby recommended that functional /accessible source of water supply be made available to farmers in the area to aid farming practice during dry season. The act of sporadic tree cutting –deforestation should be discouraged and more afforestation policies be adopted to enhance the livelihood of farmers in the area.

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Effect of Abia-CSDP demand driven development projects on livelihood of rural farmers in Abia State, Nigeria

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Abstract
The study investigated the effect of community driven infrastructural projects executed by Abia-CSDP in rural communities of the state. Multi stage sampling procedure was employed to select a sample size of 270 respondents. Data were collected using Focus Group Discussion, case studies, key information with the aid of structured questionnaire. Data generated were analyzed using mean scores. Results on Infrastructural sector analysis revealed that Educational sector had a mean score of ($\bar{x}$ = 3.52), water sector had a mean score of ($\bar{x}$ = 3.05), Transport sector had a mean score of ($\bar{x}$ = 3.67), Health score ($\bar{x}$ = 3.35) and socio-economic activities ($\bar{x}$ = 3.50). from the results, it was concluded that the bottom-top approach adopted by Abia-CSDP for rural development projects was effective in transforming the livelihood activities of the rural households in the state and recommends that efforts should be made in providing more specific agricultural infrastructural facilities as it will enhance agricultural productivity.
Key words: Abia-CSDP, Rural households and Livelihood activities

Introduction
Community development includes all strategies at the community level accrued to bringing about social and economic development (Akpomuvie, 2010). Development planners for several decades adopted approaches which were essential top-down in nature, with donors and central authorities dominating the entire process. This non -participatory model did not yield optimal results (Chebil and Haqu, 2001). According to (Anieten and Abiodun, 2016), for a rural development programme to effectively alleviate poverty. It must have the following qualities, pro poor, sustainable and must be able to empower the poor. In the early 19th century, it was widely believed that all it took to improve the economic situation of developing countries was financial inputs and modern technology, later on however; it became clear that the transfer of technology did not solve the problem. Development workers and research from the universities and research institutes began to understand the complex relationship between environment, economy, culture and politics in rural communities. They therefore began to view and tackle the various aspect of rural life as a part of integrated systems. It was realized that system for example, the complex agricultural system found in most developing countries through adaptive changes rather than by linear progresses, that is dynamic and its parts interacts by influencing each other (Obetta and Okide, 2011). It is not possible to effect a change in one element of the system in isolation without affecting other parts. Consequently, the system as a whole has to be understood in order to identify and help bring about a desired change. The Federal Government of Nigeria and the World Bank are unanimous on the desirability of the Community Driven Development (CDD) approach in the over all strategy for poverty reduction in the country.

The Community Social Development Projects (CSDP) emerged in 2008 as a new intervention strategy that was designed to effectively target social and environmental infrastructure at the community level as well as improve Local Government Areas responsibly to service delivery. The development objective of this project is to sustainably increase access of poor people to improved social and natural resource infrastructural services (CSDP, 2008).

In the light of these developments, the question that readily comes to mind with respect to governance and farming community in Abia State is whether the provision of rural infrastructure had made any effect on the livelihood of rural farmers in the state. The main objective of this study was to ascertain the (CSDP) intervention on the livelihood of rural dwellers in the largely agrarian participating communities in the state. The aim is to assess changes in the wellbeing of individual household or communities attributable to CSDP micro projects. The key performance indicator was increased number of rural dwellers with access to social services and rural infrastructure.

Methodology

The study was carried out in communities participating in Abia-CSDP projects. These communities are spread over the three agricultural zones of the state, namely Abia-South, Central and North with 7, 5 and 5 Local Government Areas respectively. Multi stage sampling procedure was used in the selection of the sample size. In the first stage, 3 Local Government Areas were selected from each zone, followed by the selection of 3 communities from each of the selected nine LGAs and selection of 3 villages each from the 9 communities. In each village, 10 rural households that actively participated and have been benefiting from the projects were selected, bringing the total to 270 respondents. The benefiting communities were identified in conjunction with the state agency. Data for the study were collected using Focus Group Discussion (FDGs), case studies, key information interviews and in-depth interview, with the aid of structured questionnaire sets. Secondary data were obtained form the Monitoring and Evaluation unit of the agency. Data collected were analyzed using mean scores, 4-point Likert type scale of SA (4), AG (3), SD (2) DIS (1).

Results and Discussion

Results in Table 1, shows the effects of infrastructure demand driven projects executed by Abia-CSDP in selected communities in the state. Educational sector had a grand mean of ($\bar{x} = 3.52$) indicating a positive outcome. According to some of the respondents, there is a reduction in the average time taken by students to get to school due to Abia-CSDP intervention in the construction and rehabilitation of schools. Measurable improvements were also recorded in number of students in science classes in schools were science laboratory were provided. Poor quality of rural schools turns out children too ill equipped to transfer technologies to their illiterate parents accurately in rapidly industrializing economy there by affecting their productivity. Oni and Adeyemi (2008) opined that poor access to infrastructural facilities especially educational facilities may led to a low agricultural productivity.

From the table also, the grand mean for water sector was ($\bar{x} = 3.05$) indicating a positive significance. During the Focus Group Discussion (FGDs) the respondents affirmed that; there is a reduction in cases of water borne disease, reduction in cost of buying water and some of the respondents expressing the opinion that there is a change in personal hygiene after the provision of water facilities by Abia-CSDP in their communities. Some of the benefitting communities, were relying on open streams as their sources of water supply for domestic use before CDSP's intervention.

Furthermore, health sector had a grand mean score of ($\bar{x} = 3.35$). The implication of the result is that, there is increase access to Medicare by members of those communities that benefitted from the intervention. There is a direct and positive relationship between the health of these rural dwellers and agricultural productivity, since about 70% of them are involved in agriculture (Odoemelam, 2012). This is also in agreement with Osabuohien and Alufohai (2015) opined that agriculture as carried out today is a dangerous occupation as some agricultural workers sustain injuries and die throughout the world. So, access to medical facilities will be a well come development. Farmers illness and diseases problem are capable of reducing agricultural productivity through the loss of productive adults and their assets with which they cope with these illness (Ulimwengu and Badiande, 2011).

Table 1: Sectorial Analysis of Projects and its Effect on Rural Farmers' Livelihood Activities

Sectorial Projects	Mean Scores
Educational sector	
Increase in school enrollment	3.42
Increase in school attendance	3.32
Short distance to school	4.00
Students are now leaving science subjects	3.34
Grand mean	3.52
Water	
Reduction in water borne disease	3.02
Reduction in average time to fetch water	3.47
Changes in personal hygiene	2.67
Grand mean	3.05
Health sector	
Increase in antenatal attendance	3.57
Distance to health centers reduced	3.0
Children immunization enhanced	3.48
Grand mean	3.35
Transport sector	
Number of vehicles plying the road increased	4.0
Reduction in cost of transportation	3.31
Reduction in average travelling time	3.68
Grand mean	3.67
Rural electrification	
Households connected to electricity	3.62
Small scale business established	3.43
Households using electrical/electronic gadgets increased	2.48
Establishment of tele centers	2.34
Grand mean	3.0
Socio economic activities	
Training skill acquisition center built	3.48
Civic centers constructed	3.40
Construction of market stalls	3.64
Grand mean	**3.50**

Source: Field Survey, 2018.

Transport sector had a grand mean score of ($\bar{x} = 3.67$). The implication of the result shows that provision of feeder roads in the rural communities had a positive effect on the rural households. Porter (2013) in his findings revealed that adequate and reliable rural needs improves productivity, enhance physical access, reduce poor people's vulnerability to shocks and stress and enable them to build their livelihood assets. These findings agree with earlier results that describe transportation as a major constraint to the marketing of agricultural products (Ayuk, 2014). The movements within rural area are made on foot by bicycles along foot path and at best on narrow roads. In order to make rural-rural and rural-urban mobility which is easier and thus facilitate the marketing of produce as well as feed the rural areas with essential commodities, there is a dire need to improve the transportation system in rural Nigeria (Emokaro and Oyoboh, 2016). Rural electrification had a grand mean of ($\bar{x} = 3.0$) implying a positive effect as well. The respondents stated, "that number of households connected to electricity was high". The best outcome, as measured during the visits to those communities recorded increase in number of new business establishment as a result of the provision of electricity through CSDP's intervention. This would go a long way in strengthening the income earning ability of beneficiaries. This intervention could easily expand agricultural value chain in the micro community in the short run and ultimately beyond on a more sustainable basis (Emokaro and Oyoboh, 2016).

Socio economic activities had a grand mean of ($\bar{x} = 3.50$). The result indicated a positive effect. The respondents stated that the skills acquired has helped them in getting extra income instead on relying only on agriculture. This would ultimately result in long term transformation of the rural economy and beyond. It equally agrees with the view of (Eboh, 2013), that such development would ultimately bring about quantitative changes which culminate in improved standard of living of rural population.

Conclusion

This study considered the effect of the CDD approach adopted by the Abia state government CSDP in transforming the lives of rural households in the state. From the result, it was observed that this approach was quite effective in achieving the objective of increasing access of the rural poor to improved infrastructure on a sustainable basis. Effort should be geared towards the provision of more specific agricultural infrastructure in rural communities to increase the productivity of the farmers and enhanced improved standard of living. Specifying rural physical infrastructure and institutional e.g. fertilizer distribution centers, advisory services, micro credits centers among others should also be provided.

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Socio-Economic Characteristics of Cocoyam Based Farmers in Ekiti State

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Abstract
The study assessed the socio-economic characteristics of cocoyam-based farmers in Ekiti State, Nigeria. A 2-stage random sampling technique was employed in the selection of 118 respondents and a structured questionnaire was used in collecting data from the respondents. Descriptive statistics and regression analysis were employed for data analysis. Findings showed that 50% of the sampled farmers were within their economic active working age. It was also revealed that 90% were men while 10% were women. The regression analysis reveals that the variables in the model were significant (P<0.05) with co-efficient of determination of 85%. About 34.7%, 25.4%, and 13.6% complained that government supports, subsidies and extension services are the major constraints faced by the farmers in the study area respectively. The study recommended that farmer's inputs should be subsidized; infrastructural facilities should be provided and more awareness on the importance of the crop should be created.
Key words: Socio-economic characteristics, Cocoyam-based farming, Ekiti State, Farmers

Introduction
Cocoyam-based production system is a process where cocoyam is been intercropped with other crops, which has been the prevalent arable cropping system since time immemorial in the large guinea savanna vegetation agriculture in Nigeria (Oluwatusin & Shittu, 2014). The predominance of the system has been occasioned by Nigeria's climate which is basically tropical and favourable for cocoyam production. Though cocoyam when cultivated as a sole crop results in high outputs, the greatest disadvantage of sole cropping is that during instances of pest or disease outbreaks, the farmer usually loses a significant part of his crops and sometimes even lose all (Matikiti *et al.*, 2016).

Cocoyam belongs to the monocotyledonous family Araceae known as the Aroids. The name cocoyam is generally applied to a variety of useful and edible species belonging to different genera including Colocasia, Xanthosoma, Alocasia, Crytospema and Amorphophallus. Cocoyam (*Colocasia spp*) is an important staple crop cultivated for food security in Nigeria and ranks third in importance after cassava and yam among the root and tuber crops cultivated and consumed (Amusa, 2012). Cocoyam is a stem tuber that is widely cultivated in the tropical regions of the world and is a well-known food plant which has a long history of cultivation(Achampong *et al.*, 2017). According to (Fadipe *et al.*, 2015), Nigeria is the largest producer of cocoyam in the world, accounting for about 40% of the total world output. Cocoyam is composed of 70-80% water, 20-25% starch and 1.5-3% protein with high minerals and vitamin nutrients (Eze, 2014). According to Talwana *et al.* (2009), cocoyam is relevant in the dietary needs of households and noted that about 280 million people eat cocoyam mainly Colocasia Esculenta and Xanthosoma Saggittifoluim (known as taro and tannia respectively in Nigeria) species worldwide. The importance of cocoyam is not only attributed to its use as source of food for man; industrially, cocoyam is used for production of alcohol, medicines, flour, starch and feed for livestock (Ijioma *et al.*, 2014). However, cocoyam has hitherto suffered stiff competition from yam, which is preferred for consumption and from cassava which yields more heavily and required less care (Awodunmuyila, 2008). According to Amusa (2012), the productivity of the crop per hectare is low which is characterized by small-scale farmers. Expansion in cocoyam production, therefore has the potential of bridging the wide demand and supply gap, and enhancing the income (thereby reducing poverty) of the rural farmers, particularly the vulnerable group.

Despite cocoyam contribution to nutritional status of the diets of Nigerians and its contribution to industrial development and creating income for farmers, production of this crop has not received required attention. Past researchers have limited themselves to the cultural practices like fertilizer application, spacing, weeding, etc., as evidenced in the studies of Baruwa and Oke (2012); Fadipe, Adenuga, and Raji (2015); Ifeanyi-Obi, Togun, Lamboll, Adesope, and Arokoyu (2017) with little emphasis on the socio-economic aspects of the production. Therefore, this study examined principally the socio-economic characteristics of cocoyam-based farming.

Methodology

This study was carried out in Ikole Local Government Area of Ekiti State occupying an area of about 374,940km^2. The primary data used was collected with a structured questionnaire administered by enumerators. A 2-stage sampling technique was used in this study. Five villages were purposely selected. A simple random sampling technique was used to select 25 respondents from each of the selected villages which brings it to a total sample size of 125 respondents but 118 questionnaire were returned and analyzed. Data were analyzed using simple descriptive statistics and multiple regression analysis. The regression model used in its implicit form is specified as follows:

$$Y = f(X1, X2, X3, X4, u)$$

Where Y = Quantity of cocoyam output in Kilogram; X1=Farm size; X2=Labour; X3=Educational level; X4 = Fertilizer and u = Error term.

Results and Discussion

Socio-Economic Characteristics of Farmers

The socioeconomic characteristics of cocoyam-based farmers as shown in Table 1 revealed that majority (50%) were between the productive age of 30-49 years while 15% of the respondents were above 60 years of age. Also, majority (90%) of the respondents were males while 10% were females. The study also revealed that about 68.6% of the respondents were married, 26.3% were single and 5.1% are widowed. The high percentage of those married in this report can be attributed to the fact that women play important role and contribute a lot to farm work (Ifeanyi-Obi *et al*., 2017). The study further revealed that majority of respondents (94%) had basic education. Educated farmers are known to be better informed, have access to information and adopt new and improved technologies. This assertion could be corroborated by works of Abosede *et al.* (2014), Bello (2015) and Mohammed *et al.* (2014). Majority (47.5%) of the respondents got their land through inheritance. Farm size is very important in agriculture because it determines the output of the farmer. Also majority (57.6%) of the farmers operates on a small scale holding of farm size less than 1 hectare. The larger percentage (44.1%) of the respondents have crop combinations of cocoyam/maize/cassava.

Table 1: Socio-Economic Characteristics of the Respondents

Socio-Economics Characteristics of the Respondents (N=118)

Variables	Frequency	Percentage
Age		
< 30	19	16.3
30-39	18	15
40-49	41	35
50-59	22	18.6
>60	18	15
Sex		
Male	106	90.00
Female	12	10.00
Marital Status		
Single	31	26.3
Married	81	68.6
Widowed	6	5.1
Education		
no formal education	7	5.9
primary education	37	31.3
secondary education	52	44.1
tertiary education	22	18.6
Method of Land Acquisition		
Inheritance	56	47.5
rent/lease	41	35
Purchased	14	11.7
cooperative society	6	5
Others	1	0.8
Farm Size		
<1 hectare	68	57.6
1-2 hectare	32	27.1
2-3 hectare	18	15.3
Enterprise Combination		
Cocoyam/Maize/Cassava	52	44.1
Cocoyam/Yam/Cassava	37	31.4
Cocoyam/Maize/Vegetable	24	20.3
Cocoyam/Cowpea	6	5.2

Source: Field Survey, 2017

Regression Analysis

All specified variables in the model were significant (P<0.05). The regression result clearly shows that there is a relationship between the key inputs; land, labor, education and fertilizer, and the output. This simply implies that if there is an increase in these variables there will be a resultant increase in the output and vice-versa.

Table 2: Regression Analysis

	Constant	Land	Labor	Education	Fertilizer	Adjusted R	F-Value
Cocoyam-based system							
Cocoyam/Maize/Cassava	19.214	89.924	2.589	0.017	0.179	0.642	649.04
	0.314*	0.098	5.644*	0.916	7.025*		
Cocoyam/Yam/Cassava	2.007	0.133	0.041	0.0042	0.539	0.748	479.17
	3.775*	0.35	7.689*	1.022	4.231*		
Cocoyam/Maize/Vegetable	1.055	0.213	0.732	0.035	3004.3	0.846	314.87
	8.511**	7.027**	2.781**	1.988	2.126*		

Cocoyam/Cowpea	-8.768	9.02	4	7.462	2368	0.423	314.87
	3.819**	1.498	2.031*	0.76	3.935*		

* = significant at 0.05, ** = significant at 0.01
Source: Field Survey 2017.

Constraints
Table 3 reveals that about 34.7%, 25.4%, and 13.6% complained that government supports, subsidies and extension services are the major constraints faced by the farmers in the study area respectively.

Table 3: Frequency Distribution of the Constraints Faced by Farmers

Constraints	Frequency	Percentage
Lack of information	3	2.5
Irregular extension services	16	13.6
No government subsidies	30	25.4
Lack of access to improved varieties	15	12.7
Absence of government support	41	34.7
Low awareness level on the crop	7	5.9
Poor research on the crop	6	5.1
Total	118	100

Conclusion and Recommendations
The study examined the socio-economic characteristics of cocoyam-based farming in the study area. From the study, it shows that cocoyam-based production has a bright prospect despite numerous constraints faced by farmers. Increase in production could be achieved if both institutional and infrastructural facilities are provided in the study area.
The study recommended that inputs should be subsidized, infrastructural facilities like good road network to aid the transportation of produce to the market in order to reduce production cost should be provided by the government, and more awareness should be created on the importance of the crop.

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Assessment Of Awareness and Perceived Benefits of Yellow Root Cassava Value Added Innovation in Umuahia- North LGA Abia State

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Abstract
The study assessed the awareness and perceived benefits of yellow root cassava value-added innovation on livelihood of rural farmers in Umuahia North Local Government Area of, Abia state, Nigeria. Multi- stage sampling technique was used in the study. Sixty (60) farmers were randomly selected from the host of farmers in Umuahia North Local Government for the purpose of this study. A structured questionnaire was used to obtain data from the farmers. Data collected were analyzed using descriptive statistics such as frequency distribution tables, mean and percentages. The result showed that 60% of the respondents make use of value added cassava as food while 40% used it as a source of income. The women also have their constraints in processing the products due to poor yield of cassava (27%) and lack of processing equipment (24%). The study recommended that improved, high yielding cassava varieties and processing equipments shall be made available to the women for increased production.
Keywords; impact, assessment, yellow root, cassava

Introduction
The large component of vulnerable population - women of childbearing age and children – in cassava producing areas are at risk of Vitamin A deficiency. It was against this background that researchers at National Root Crops Research Institute Umudike (NRCRI) put down efforts to release six yellow varieties of Cassava that are rich in vitamin A. The development of the varieties was a major breakthrough that would change the nutritional status of people living on cassava-based foods. The new varieties contain higher amounts of beta-carotene – the substance that the body converts to vitamin A – and are at least six times more nutritious than the common white-fleshed cassava. Vitamin A deficiency can impair the body's immunity to infectious diseases and cause eye damage that can lead to blindness and even death. Nearly one in three Nigerian children under five and one-quarter of all pregnant women in the country are vitamin A deficient. The newly released vitamin A cassava varieties can provide up to 40 percent of the vitamin A recommended daily allowance for children under five. They are twenty-five percent richer in beta-carotene than the first set of vitamin A cassava varieties released in 2011 and which are now being grown by over 250,000 Nigerian farmers. The newer improved varieties are expected to gradually replace the earlier ones (Egesi & Eke-Okoro, 2013). Value-addition to these yellow cassava varieties through processing them into different products will increase the income of the farmers.
Processing is the conversion of edible food into another more acceptable or more convenient to the consumer. Cassava can be processed into many products which may be put into variety of uses. Various people use cassava for food. In Abia State, majority use cassava for garri while many use it for *fufu* and *abacha*. This shows that the major diet from cassava in rural Abia State were *garri* and *fufu* (Nwakor & Nwakor, 2012). The rising demand for more processed agricultural products

has created new industries to supply better quality products in more readily usable forms. Processed cassava products like odourless *fufu* have high capacity to wedge hunger for a longer period of time (Amamgbo *et al.*, 2002).

Objective of the study

The broad objective of the study is to find out the impact assessment of yellow root cassava value addition among rural women in Umuahia North.

❖ To describe the socioeconomic characteristics of rural farmers, determine the impact of selected cassava value added innovations (cassava fufu, high quality cassava flour, chips, garri and starch)

❖ To ascertain the awareness and perceived benefits of this innovation among the respondents

❖ To identify constraints encountered by rural women in the yellow root cassava value added innovation.

Methodology

The study was conducted in Umuahia North Local Government Area (LGA) of Abia State of Nigeria in 2018. Four communities were randomly selected in Umuahia North LGA. They were Ohia, Ossai, Umuoriehi and Amafor. In each of these communities 15 women were randomly selected and interviewed using structured questionnaire. Data collected were analyzed using descriptive statistics, such as frequency tables, percentages, and means.

Results and Discussion

Socio-Economic Characteristics of the Respondents

Table 1 showed the distribution of respondents according to their socio-economic characteristics. The result indicated that the average age of the respondents was 42.81 years. This implies that majority of the farmers were in their active age and ready to get involved in cassava business. The majority (63.33%) of the farmers were females. This suggests that women are more involved in cassava production. Majority (65%) of the famers were married and majority of the respondents had formal education. The result also indicated that the average income of the farmers was ₦58, 083.

Table1: Socio-economic Characteristics of the Respondents

Variable	Frequency	Percentage	Mean
Age			
20-30	17	28.33	42.81
33- 39	9	15	
41 – 49	18	28.34	
54 – 59	6	10.01	
60 – 68	6	10.01	
70 -75	3	5.01	
	60	100	
Gender			
Male	38	36.67	0.63
Female	22	63.33	
	60	100	
Marital status			
Married	38	63.33	0.63
No married	22	36.67	
	60	100	
Educational level			
Non-formal	5	8.33	
Primary	17	28.33	
Secondary	23	38.33	12
Tertiary	15	25.00	
Farm experience			
10 years	43	71.67	
10 years and above	60	100.00	10.16
Farm size			
1 hectare	25	41.67	0.98
1– 2 hectare	13	21.67	
2 – 3 hectare	20	33.33	
3 - above	2	3.33	
In come			
10,000 – 37,000	24	38.29	58083
40,000 – 59,000	20	362.35	
60,000 – 77,000	8	13.35	
80,000 and above	10	16.69	
	60	100	

Table 2 showed the distribution of respondents according to awareness and benefit of yellow root cassava. The result showed that 60% of the respondents used yellow root cassava for food while 40% used it as source of income. All the respondents were aware of yellow root cassava. The result showed that 48.33% of respondents processed the yellow root cassava into garri and 45% of the respondents consumed about 100 – 200kg of their products. The result showed that 58.33% of the farmers sold garri from yellow root cassava.

Table 2: Distribution of respondents according to their awareness and benefits of yellow root

Options	Frequency	Percentage	Mean
Benefit			
Food	36	60.00	
Income	24	40.00	
Awareness			
Products	14	23.33	
Fufu	29	48.33	
Garri	15	25.00	1
Flour	1	1.67	
Chin-chin	1	1.67	
Quantity consumed			
<100kg	27	45.00	
100- 200kg	11	18.33	
201 – 300kg	8	13.33	1.68
Above	8	13.33	1.68
	60	100.00	
Value added sold			
Fufu	10	16.67	
Garri	35	58.33	1.26
Flour	8	13.33	
Chips	4	6.67	
Chinchin	2	3.33	
Bread	1	1.67	
	60	**100.00**	

Constraints

Constraint in the production of yellow root cassava is presented in a chart as shown in Figure 1. The major constraints militating against yellow root cassava production were poor yield of yellow root cassava (27%), followed by unavailability of processing equipment (24%), poor education of farmers and lack of interest in yellow root.

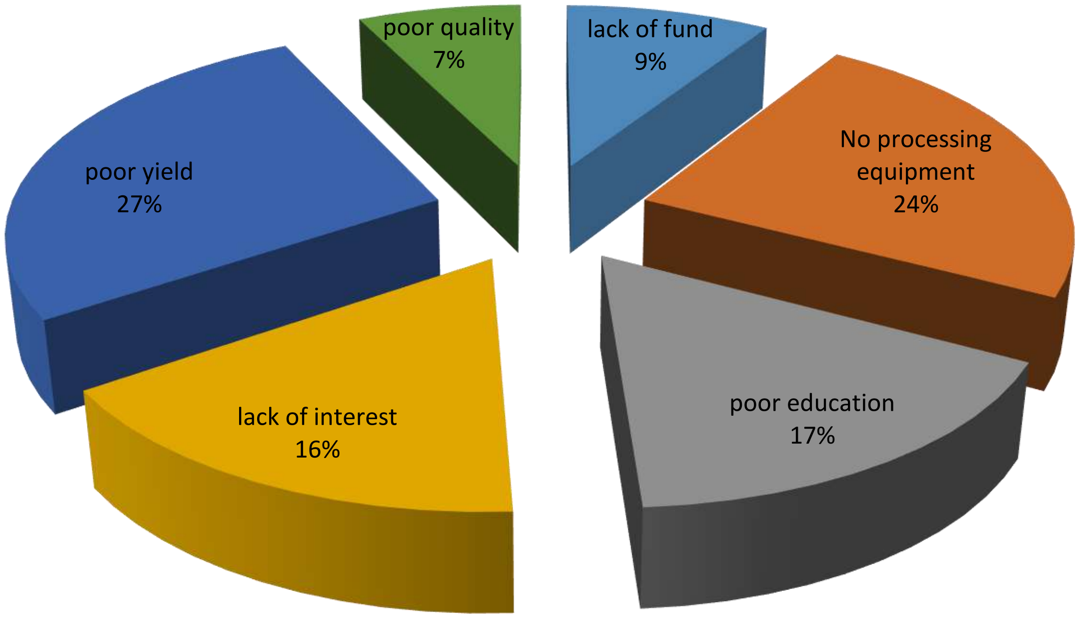

Figure 1: Constraints to production of yellow root cassava

Conclusion

The findings indicate that farmers in Umuahia were using yellow root as source of food and income. The major products from yellow root cassava were garri, flour and fufu, garri. The major constraints in the production of yellow root cassava were poor yield and lack of processing equipment.

Recommendations

- Farmers in Umuahia North LGA need to be provided with fertilizers and organic manure to improve the yield of crops.
- Processing equipment should be made available to rural dwellers in the study areas.
- Farmers need to be trained on how to diversify the use of yellow root cassava through processing it to many other products outside garri, flour, and fufu.

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Economic Analysis of Smoked Fish Marketing in Ikorodu LGA, Lagos State

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Abstract
This study examined the economics of smoked fish marketing in Ikorodu Local Government Area, Lagos State. One hundred and twenty smoked fish marketers were selected using multi-stage sampling procedure. The data collected through the use of structured questionnaire were analysed using descriptive statistics, marketing margin, and inferential statistics such as correlation and t-test. The findings revealed an average marketing margin of 15%. Lack of capital, high taxes, poor feeder roads, high cost of transportation, price fluctuations were the major constraints the marketers faced in the study area. These numerous marketing problems could explain the low profitability among smoked fish marketers. It is recommended that inactive cooperatives should be strengthened so that members could secure better bargaining power. Fish smoking could be achieved using cheaper alternatives to wood like rice, husks, wood wastes and maize cobs. Government could also assist marketers with funds in form of aids, grants and soft loans; smoking keens, cold rooms and warehouses for proper storage and marketing.
Keywords: Marketing, smoked fish, marketing margin, profitability

Introduction
Fish is an important component of total human food consumption, it is one of the main sources of protein and fat, it has some peculiar qualities that make it a valuable source of nutrient. The protein in fish is adequate, important and digestible (Apata, 2002). It has no religious rejection or biases compared to other sources of protein, like pig which is condemned and religiously rejected by Islam. Fish is a good source of sulphur and essential amino acids such as lysine, leucine, valine and arginine and it is therefore suitable for supplementing diets of high carbohydrates contents (Amao *et al*., 2006). It has high content of Polyunsaturated (Omega III) fatty acids, which are important in lowering blood cholesterol level and high blood pressure (Coaster & Otufale, 2010). It has also been implicated to have decreased the risk of bowel cancer and reduces insulin resistance in skeletal muscles (Esiobu *et al.,* 2014). Fish and fish products are known worldwide as a very important diet because of their high nutritive quality and significance in improving human health. Fish plays a vital role in feeding the world's population and contributing significantly to the dietary protein intake of billions of the populace (Adeosun & Adebukola, 2012). On a global scale, almost 16 percent of total average intake of animal protein was attributable to fish in 1988 (FAO, 2012).

Recently demand for fish product has doubled as other sources of animal protein have become expensive due to pressure by the ever increasing population and the high cost of the other animal protein source (Ojo & Fagbenro, 2004). Despite Nigeria's rich moderate tider dynamics in her coast and the existence of high fisheries potentials, notably within the upwelling zones of the continental shelf or the enrichment of the land based sources through the rivers, fish production has for a long time consisted of localized activities aimed at providing protein to her teeming population. Nigeria's fishing sector accounts for about 4% of GDP, and 50% of the animal protein intake (Oluyole, 2010). The Food and Agriculture Organization (2012) recommended that a person takes 35 grams per caput of animal protein per day for sustainable growth and development. Fish which contributes 36.6 grams per day of net protein utilization in Nigerian homes is still below the recommended requirement by the WHO (Ohen & Abang, 2009). Malnutrition is a major health hazard in many developing countries. It impedes health, work-efficiency, productivity and general economic progress. It has been recognized that fish is a veritable source of protein, therefore if readily available and affordable fish can alleviate the problem of malnutrition.

Fish marketing is one of the oldest livelihood income generating activities of man since time immemorial. Fish marketing describes all various activities which concerned from the point of catching/harvesting of fish, to processing and ultimately to the point of final consumption. Agricultural marketing dictates how often the producer will increase and/or produce their output/yield. A good marketing organization directs production along the most suitable needs of the consumers (Esiobu *et al*., 2014). The market mechanisms have to be efficient to be able to play the role of propelling yield. An efficient market system therefore is the one that provides satisfactory and cheap services to consumers or one that maximize the ratio of input and output of marketing. Fish supply and marketing suffer from various set- backs, ranging from shortage of supply, price fluctuation due to drying up of the source and spoilage in transit amongst others.

Agricultural marketing is central to agricultural development and the overall growth and development of the economy. Previous studies have shown that efficient marketing system stimulates agricultural production (Adescope, Ajibefun and Akeremale 2005 as cited in Awoyinka, 2009). In Nigeria, the annual demand for fish far exceeds local production such that according to the Federal Bureau of Statistics, over 800,000 metric tonnes of fish are imported. This high level of fish importation is absurd considering nutritional and other economic importance of fish, and rich coastal heritage and endowment of the country. As important as marketing is, most of the studies on fish have concentrated on production (Inoni, 2007; Kudi, 2008; Dagtekin & Emeksiz, 2009). Besides, the empirical evidences emerging from few studies (Ohen and Abang, 2009; Coaster and Otufale, 2010 etc) yielded mixed results that are inconclusive and conflicting. Particularly, in Lagos State little or no study has rigorously modelled the economic analysis of smoked fish marketing. The specific objectives of the study are to;

i. determine the marketing margin of the smoked fish marketers;
ii. assess the relationship between socio-economic characteristics of respondents and their returns from fish marketing;
iii. identify constraints associated with smoked fish marketing in the study area.

The hypothesis tested in the null form was "smoked fish marketing is not profitable in the study area".

Methodology

The study was carried out in Ikorodu Local Government Area (LGA) of Lagos State. Ikorodu LGA is situated approximately 36 km North of Lagos. It is located along the Lagos Lagoon and shares a boundary with Ogun State. It is bounded to the South by the Lagos Lagoon, to the North by a boundary with Ogun State, and to the East by a boundary with Agbowa-Ikosi, a town in Epe Division of Lagos State. Ikorodu LGA has a coordinate 6°36′N 3°30′E / 6.600°N 3.500°E and a population of 535,619 people (NPC, 2006). Ikorodu LGA consists of nineteen (19) wards. The main industries in the town are trading, farming and fishing. Major water bodies in Ikorodu include Agboyi River, Ajegunle River, Majidun River, Ogudu River, River Ogun, and the Ikorodu Fish Farm Estate. These river bodies serve as a veritable means of livelihood to residents of Ikorodu LGA who are involved in fishing activities. As a result of the abundance of river bodies, fishing and fish marketing is fast becoming a popular trade among youths and young school leavers in Lagos as a whole, and Ikorodu LGA in particular.

The population of the study consisted smoked fish traders in Ikorodu LGA of Lagos State. A multi-stage sampling procedure was employed in the selection of respondents. At the first stage, purposive sampling technique was used to select four (4) wards in Ikorodu LGA namely; Agbala, Ibeshe, Ipakodo, Odogunyan, due to their relative high level of smoked fish marketers and processors. In the second stage a simple random sampling method was used to select 51 smoked fish traders from Agbala market; 22 from Beshe market; 17 from Ipakodo market; 30 from Odogunyan market applying a uniform sampling proportion of 35% to their sampling frame. Thus, a sample size of one hundred and twenty (120) respondents was used. Primary data was collected using a structured questionnaire. Marketing margin analysis, correlation, Likert scale rating (which was used to arrange the data) and one-sample t-test were used to analyse the data. The four Likert scale was specified as follows: Very serious (VS) =4, Serious (S) =3, Not serious (NS) =2, Not a Problem (NP) =1

Model Specification
Marketing margin

$$\text{Marketing Margin} = \frac{Selling\ price - purchase\ price}{selling\ price} \times 100$$

Results and Discussion

Marketing Margin of Smoked Fish marketers
Table 1 presents the result of the marketing margin of respondents in the study area. The average marketing margin was 15%. This implied that 15 percent profit would be realized from every purchase made. Majority of the respondents (63.3%) had a marketing margin of between 10% and 20%, 10.8% had between 20% and 30% while 21.7% had below the average marketing margin. This low marketing margin suggests low returns from fish marketing. This result is in line with the findings of Enete and Agbugba (2008) who obtained 22.3% marketing margin for wholesalers that engaged in charcoal marketing in Abia State. Also, marketing margins of 11.9 and 24.4% were obtained for pineapple marketing in rural and urban areas in Lagos State by Oladapo *et al.,* (2007); which are similar to this study.

Also, as a rule of thumb, Riley (1972) had reported that efficient markets in developing countries must have a retail margin of less than 10 percent of the consumers 'price for non-perishable goods. Thus, marketing margin of 15% found in this study therefore does not suggested inefficiency since fish is perishable.

Table 1: Marketing Margin of Smoked Fish Marketers

Class Interval	Frequency	Percentage	Mean
4.50 - 10.00	26	21.7	14.97%
10.01- 20.00	76	63.3	
20.01- 30.00	13	10.8	
30.01-32.40	5	4.2	

Source: Field survey, 2018.

Relationship between Socio- Economic Characteristics of Marketers and their Profit Margin
Table 2 showed the Pearson correlation result which was used to predict the relationship between socio-economic characteristics of smoked fish marketer and their profit margin. The result showed that majority of the socio-economic variables-age, level of education, household size and fish experience had no significant relationship with the profit margin of smoked fish marketers. This implies that an increase, or decrease in these variables will have little or no effect on the marketer's profit margin. On the other hand, only annual income had a positive and significant relationship with their profit margin at 10% level of significance. This means that an increase in annual income of smoked fish marketer will increase their profit margin. This result implies that increasing the financial base of the marketers can go a long way in expanding their business profitably.

Table 2: Correlation result showing relationship between Socio-economic characteristics of respondents and their Marketing Margin

Variables	Pearson correlation	Sig
Age	-0.004	0.968
Level of education	0.004	0.963
Household size	0.084	0.360
Annual income	0.430**	0.000
Marketing experience	-0.068	0.458

Dependent variable - Profit. ** significant at 1% **Source**: Field Survey, 2018.

Test of profitability of Smoked-Fish Marketing
Table 3 presents the results of profitability of smoked fish marketers in the study area. The average revenue for smoked fish marketers was ₦46,760 while the average variable cost was ₦40,689. Although the mean difference shows a value of 6070.167 which indicated that the business may be able to pay its bill, there was no significant difference ($t=1.08$; $P \geq 0.10$) between the revenue and cost incurred by smoked fish marketers. This indicates that the smoked fish

marketing is not profitable in the study area. Therefore, the null hypothesis which stated that smoked-fish marketing is not profitable in the study area is accepted.

Table 3: Test for profitability of Smoked Fish Marketing

Groups	Mean	Mean difference	t-value	Df	Sig
Revenue	46760	6070.167	1.082	238	0.280
Cost	40689				

Source: Field Survey, 2018.

Constraints of Smoked Fish Marketing

Table 4 showed the constraints of fish marketers in the study area. Lack of capital, High taxes, Price fluctuation (t=7.78, 16.83, 14.11;P≥0.01) were the challenges that affect smoked fish marketing in the study area. These factors were very critical to the availability, quality and accessibility of fish consumed, and also, on the efficiency and profitability of smoked-fish marketing. As such, these challenges if not addressed could serve as disincentives to fish marketers with its resultant losses in employment, income and socio-economic growth and development of the country. Other constraints which were found to have significant effect on smoked fish marketing include high cost of fishing materials, high transportation cost, inadequate storage facilities, lack of electricity supply, poor feeder roads, consumers' choice on fishes, union activities, insect infestation and processing problems.

Table 4: One sample t-test showing constraints to Smoked Fish Marketing (test value=2.50)

Constraints	Mean	Std. Dev	Mean Diff	**t-value**	Sig. (2-taild)	**Rating**
Lack of capital	2.98	0.419	0.475	17.78	0.000	Ist
High tax	3.14	0.395	0.64	16.83	0.000	2nd
Price fluctuations	2.83	0.436	0.33	14.11	0.000	3rd
Poor feeder roads	3.05	0.427	0.55	12.41	0.000	4th
High cost of transportation	3.04	0.353	0.54	9.32	0.000	5th
Union activities	2.82	0.43	0.32	8.37	0.000	6th
Problem of processing	2.55	0.659	0.05	8.07	0.408	7th
Consumer`s choice on fishes	2.62	0.758	0.117	4.07	0.000	8th
High cost of fishing materials	2.88	0.44	0.375	1.69	0.094	9th
Inadequate storage facilities	2.58	0.694	0.075	1.18	0.239	10th
Insect infestation	2.32	0.85	-0.183	0.83	0.020	11th
Lack of electricity supply	2.73	0.63	0.233	-2.36	0.000	12th

Source: Field Survey (2018).

Conclusion and Recommendations

There was no significant difference in the revenue and the cost of the smoked fish marketers, indicating that the smoked fish marketing is not profitable in the study area. An average marketing margin of 15% was recorded. This suggests low return for marketers which may discourage others from venturing into the business. It was also shown that increase in annual income will increase the smoked-fish marketers' profit margin. Lack of capital, High taxes and price fluctuations were the major constraints of smoked fish marketers in the study area.

Inactive fishermen cooperatives should be strengthened so that members could secure fishing inputs. This could enhance better bargaining power and thus give more access to better market prices that will translate to higher returns. Due to inadequate and high cost of fish preservation/storage in the area, fish smoking can be achieved by using cheaper alternatives of fuel such as rice husks, wood wastes and maize cobs as substitutes for wood. Government should assist marketers with smoking keens, cold rooms and warehouses which enhance proper storage. Funds in forms of aids and soft loans should be provided by the government to the marketers. This will increase the capital base of the individual fish marketers and also attract more people to the business. This will result in a more competitive market where prices of fish will be determined solely by the forces of demand and supply thereby making fish easily available and affordable to majority of Nigerians;

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Assessment of Consumers Preference and Consumption Pattern of Catfish in Ibeju-Lekki LGA of Lagos state, Nigeria

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Abstract
The assessment of consumers' preference and consumption pattern of catfish was studied. A total of eighty (80) respondents were selected by the use of multistage random sampling technique. Descriptive statistics such as percentage and frequencies were used to determine the effect of socio-economic characteristics of the respondent and the constraint to consumer preference and consumption pattern in the study area. The result showed that a higher percentage of the respondents consume fresh catfish fish in the study area. The result shows that majority of the respondents preferred fresh catfish, followed by smoked fish and frozen fish. Therefore, for the current level of fish consumption in the study area to be sustained and improved upon, strategies towards boosting the production of fish both in the study area as well as at the national level should focus on creation of income-enhancing jobs and trainings through capacity building in fish production and value addition to the products.
Keywords: Consumers, Preference, Pattern, Catfish

Introduction
Catfish is an important source of protein in Nigeria. In the last three decades, the Federal Department of Fisheries (FDF) statistics show that catfish consumption in Nigeria has been increasing at no less than 5.6% per annum (FAO, 2006). The Nigeria Bureau of Statistics (NBS, 2012) backed this by stating that Nigeria is the largest producer of catfish in Africa. It must be noted that out of the 15,489 tonnes of fish produced in Nigeria in 2011, catfish production accounted for about 4,627 metric tonnes (NBS, 2012). Catfish are a diverse group of ray-finned fish. Catfishes especially members of the family Clariidae are very important in Africa and are very abundant in commercial catches in Nigeria. Members of this family that are very common in the study area include Heterobranchus species (*H. bidorsalis and H. longifilis*) and Clarias species (*C. gariepinus and C. anguillaris*) and their cultured hybrids (Heteroclarias). These species are very important because they not only keep well in both fresh and dried condition, but are highly valued and enjoyed a greater level of popularity among consumers. The economic importance of Heterobranchus and Clarias catfishes and their hybrids is enhanced by their hardiness and adaptability to adverse environmental conditions, tolerance of high density culture, resistance to diseases, fast growth rate, high consumer ranking and their ability to accept or thrive on cheap feed.

Consumer behavior for fish with respect to consumers' taste, preference, food habits, family income and consumption expenditure on fish and related commodity is essentially important from its production, processing and marketing point of view. Preference is considered to be major factor influencing general food consumption behaviour (Myriand *et al*., 2000). Pieniak *et al*. (2008) reported that fish consumption is mostly affected by tradition and habit and the level of consumption is also enhanced by nutritional awareness. Consumer preference for food items is an important variable used in determining the extent on the degree of household purchasing ability. Households make choice out of various food items available at their disposal and this in turn determines the level and extent to which consumption would be based. Therefore, an analysis of consumer preference for forms of fish is important, and this may be useful for fish production, planning, trade, and distribution and marketing.

Many catfish consumers are known to consider various factors such as acceptance of product, preference and pattern in which it is been consumed amongst others before making their demand for the product. The term consumer preference refers to the consumers' general likes and dislikes for products (e.g. consumers general likeness for fried chicken better than hash browned potatoes) while consumer acceptance on the other hand refers to the consumers' reaction to a specific product (i.e. method of preparation, specific serving temperature, specific ingredient and so on) according to Brunso (2009). He went further to state that these two terms are not uniformly agreed upon as consumer preference is measured by the use of questionnaire in which the respondents indicates their degree of preference to a produce while consumer acceptance can only be obtained from the respondents reaction to the actual food item which is obtained typically from a kitchen experiment or from an actual field situation. But for the purpose of this study, the field situation will be adopted to test the consumer acceptance of catfish in Enugu State. In line with the above, Akeson-Samson (2005) reported that consumers usually have a natural preference for a particular fish species while acceptability may be influenced by taste, price and income of consumers. As suggested by Grunert *et al*. (2003), consumers learn about their preferences over time by observing the relationships between their own reactions to alternatives and the attributes of the alternatives. The study analyzed consumers' preference of catfish in Ibeju-Lekki Local Government Area (LGA) of Lagos State Nigeria.

Methodology

This study was carried out in Ibeju Lekki LGA of Lagos State, Nigeria. Ibeju-Lekki is bounded in the east by Epe local government while its southern end joins the Atlantic Ocean. It is about 75 kilometres long and 20 kilometres at its widest point. According to the 2006 national census, the total population of Ibeju-Lekki is 117,793 consisting of 60,729 males and 57,064 females. Ibeju – Lekki is a rural community with eleven rural markets located at various villages and natural resource-based economic activities like fishing, agriculture, timber /saw-milling, mat/ raffia weaving, oil-palm processing and emerging eco-tourism. Towns and villages that make up Ibeju/Lekki LGA include Aiyeteju, Awoyaya, Bogoje, Akodo, Eputu, Badore, Elerangbe, and Iberikodo. Ibeju/ Lekki LGA also hosts the Lekki Local Council Development Area. A random sampling technique was used to select four (4) communities (Aiyeteju, Awoyaya, Badore and Iberikodo) out of the various communities in the study area. Questionnaire was administered on twenty (20) respondents in each of the four (4) selected communities to make total of eighty (80) respondents.

The data collected was using descriptive statistics and chi-square analysis. The computation of chi- square of statistic is given by

$$X^2 = \sum \frac{(Oi - Ei)^2}{Ei}$$

Where; O = Observed frequency, E = Expected or theoretical frequency, $\sum$ = summation sign, X^2 = Chi square

Results and Discussion

Socio-Economic Characteristics of Respondents

The socio-economic characteristics of respondents is presented in Table 1. Education is taste changing and usually affects the consumption pattern and nutrition of a household. This is because as the years of formal education increase, consumers become increasingly aware of the nutritional value of certain food items like fish, meat and eggs and subsequently increase their consumption of them. Household size is another important variable affecting the consumption pattern of households it can be observed that a large proportion of households fall within household size of 4-6 persons per household, accounting for about 52.5 % of the total number of sampled households. This was followed by household with 7 - 9 persons per household representing about 31.5% of sampled households. The lowest household size fell within the range of 10 persons above per household, accounting for approximately 3.7% of the total sampled households. This tendency towards small family size in the study area may be attributable to the high level of education of respondents and their corresponding awareness of family planning measures. There is a tendency for the age of the household head to affect the consumption pattern of a household and may determine to an extent the type, quality and nutrition of a given household. a large number of household heads (38) fell within the age group of 31 – 45 years and represented about 47.5% of the sample size. This was followed by respondents within the age groups of 15 – 30 years, 46 – 60 years and 60 years above representing 32.5%, 15% and 5% of the total sample respectively.

Table 1: Socio-Economic Characteristics of Respondents

Characteristics	Values	Aiyeteju Frequency	Iawoyaya frequency	Badore Frequency	Iberikodo Frequency	Total frequency
Age Of Consumers (Years)	15 – 30	7	8	6	5	26
	31 – 45	10	9	9	10	38
	46 – 60	2	3	3	4	12
	60 above	1	0	2	1	4
Household Monthly Income(₦)	Below 10,000	1	1	2	0	4
	10,000-20,000	7	5	6	5	23
	20,000 35,000	7	10	8	9	34
	35,000 above	5	4	4	6	19
Monthly expenditure on food (₦)	Below 3000	9	10	8	7	34
	3000-17,500	8	8	7	7	30
	17,500-30,000	3	1	4	4	12
	30000 above	0	1	1	2	4
Monthly expenditure on animal protein (₦)	below 2000	5	7	11	7	30
	2000-4000	10	10	6	7	33
	4000-6000	4	3	3	6	16
	6000 above	1	0	0	0	1
Monthly expenditure on fish protein (#)	Below 2000	10	8	7	8	33
	2000-4000	6	7	7	5	25
	4000-6000	2	4	5	5	16
	6000 above	2	1	1	2	6
Household size	1 – 3	4	3	2	1	10
	4 – 6	10	11	9	12	42
	7 – 9	6	4	8	7	25
	10 above	0	2	1	0	3
Level of education	Illiterate	5	3	4	2	14
	Adult edu	0	0	1	1	2
	Pry/second	14	15	10	11	50
	Post sec	1	2	5	6	14
Occupation	Civil service	1	2	3	4	10
	Non civil service	12	10	11	8	41
	Artisans	5	2	5	7	19
	Student	2	6	1	1	10

Source: Field survey 2017

Table 2 shows that, 40% of the respondents were male, while 60% were female. From the data collected, it was observed that majority of the respondent in the study area were females.

Table 2: Distribution of the respondents according to gender

Gender	Frequency	Percentage
Male	32	40
Female	48	60
Total	**80**	**100**

Source: Survey Data 2017.

Consumer Choice

The result in the Table 3 showed the consumer preference in relation to their choice the Fresh water fishes (56.25%), smoked fish (28.75) and frozen fish (15%). This result shows that a higher percentage of the respondents consume fresh water fish in the study area.

Table 3: Distribution of respondent according to consumer choice

Consumer choice	Frequency	Percentage
Fresh catfish	45	56.25
Smoked catfish	23	28.75
Frozen catfish	12	15
Total	80	100

Source: Survey Data 2017

Table 4: Distribution of respondents according to consumers' preference (Chi-square)

Location/Preference	Fresh water fish	Smoked fish	Frozen Fish	Chi Square Calculated
Aiyeteju	12	05	03	21.14***
Awoyaya	10	06	03	
Badore	09	07	04	
Iberikodo	14	05	02	
Total	45	23	12	

Source: Survey Data 2017; ***Significant at 1% level

There is significant difference in the socio economic returns in the forms of the catfish consumed.

Constraints

Table 5 showed that among the constraints affecting the consumption of Clarias fish in the study area the high cost of fish (28.75%) and the low income level of the consumer (26.25%) constitute the highest level in the constraint.

Table 5: Distribution of respondents according to constraints

Constraints	Frequency	Percentage
High cost of fish	23	28.75
Rapid fish Spoilage	18	22.5
Health Reason	12	15.00
Religious Belief	6	7.50
Low income level of consumer	21	26.25
Total	**80**	**100**

Conclusion and Recommendations

The result of analysis in this survey showed that catfish an animal protein sources is highly consumed among the respondents in Ibeju Lekki Local Government Area. The result shows that majority of the respondents preferred fresh catfish, followed by smoked fish and frozen fish. This result shows that a higher percentage of the respondents consume fresh catfish fish in the study area. Therefore, for the current level of fish consumption in the study area to be sustained and improved upon, strategies towards boosting the production of fish both in the study area as well as at the national level should focus on creation of income-enhancing jobs and trainings through capacity building in fish production and value addition to the products. These should be complemented with strategies of equitable income distribution and food and nutritional awareness programmes. As household income increases, the importance of fish as a protein source in the diet should become more pronounced and increased for the much publicized, aggressive and far reaching awareness campaign. These will help reduce malnutrition and food insecurity problems, increase productivity among the populace and eventually lead to national development.

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Economic Analysis of Ornamental Fish Marketers across Nigeria

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Abstract

The study analyzed the economics of ornamental fish marketers across the nation. The specific objectives were To: profile the socio-economic characteristics of the ornamental fish traders, estimate the gross margin and to describe the constraints affecting ornamental Fish Marketing. A two-stage sampling technique was used to select Ornamental Fish traders. The traders were stratified into fishermen, middlemen and exporters, from where 50% sampling from each stratum was carried out. A total sample size of 196 Ornamental Fish traders located in 14 producing States of Nigeria (Lagos, Ogun, Edo, Delta, Rivers, Bayelsa, Abia, Cross River, Akwa Ibom, Kano, Benue, Ondo, Niger and Nassarawa) was used for the study. This includes 139 fishermen, 40 middlemen and 17 exporters. Data were collected on personal characteristics of respondents, sources of fund, types of fish holding facilities, transportation and labour costs, quantity and types of and cost of Ornamental Fish supplied, and revenue generated on quarterly basis using structured questionnaire. Data were analyzed using descriptive statistics, gross margin and multiple regression models at p=0.05. Male respondents were 91.3%; this includes 72.0%, 19.6% and 8.4% of fishermen, middlemen and exporters respectively. The mean ages of the fishermen, middlemen and exporters were 47.3 ± 1.2, 44.5 ± 1.5, and 42.6 ± 2.3 years respectively. Respondents with no formal education, primary school leaving certificate, secondary school certificate, and tertiary education were 37.3%, 32.3%, 23.5% and 6.1% respectively. The Ornamental Fish marketing channel involved fish sales from fishermen to middlemen who finally sell to consumers. Gross margin of the middlemen were highest in the first (₦9,288,876) and third (₦4,054,679) quarters, while the gross margin of the exporters were highest in the second (₦3,485,961) and fourth (₦4,088,522) quarters of the year. Exporters had the highest average marketing efficiency (85.1%) throughout the four quarters of the year. Factors that significantly influenced the supply of Ornamental Fish were start-up capital (β = 0.98) and membership of association (β = 0.32). Supply of fish by middlemen were significantly influenced by international price (β = -0.61), membership of association (β = -1.33), and educational qualification (β = 1.03). Only capital (β = 0.00) had significant influence on exporters demand for Ornamental Fish. Lack of capital and seasonality of fish species (100.0%) were the major constraints to Ornamental Fish trade.
***Keywords**: Ornamental fish, Marketing efficiency, Market channel, Fish traders*

Introduction

Nigeria is blessed with an abundant variety of fish species some of which have been exported over the years. Large quantities of fishes and fishery products are exported from Nigeria in different forms and this has been a source of foreign exchange earnings for the country. An estimate value of exports in the fishery sub-sector is approximately $31 million for shrimps, sole fish cat fish and crabs. More than US $3million was realized from sales of ornamental live fishes in 2007 (Fisheries Statistics of Nigeria, 2008) In the United States the ornamental fisheries resource is a great source of income opportunity. In 1996 the United States imports and exports in ornamental fisheries were valued at approximately $1000 million. In Florida, cultured fresh water and collected salt water species accounted for $70 million and $4 million respectively in annual dockside revenues (Chapman *et al*, 1997). The United States fish farmers of just two hundred people within Florida province have been able to generate a large amount of revenue from the rearing and marketing of tropical ornamental fishes. This indicates a great success in National income generation to the United States through the effort of the Florida farmers.(Chapman *et al*, 1997). Ornamental Fishes are used in indoor recreation and usually kept in aquarium. An aquarium is an enclosed volume of water containing a mixture of aquatic organisms. It is a water-holding structure made of glass for keeping ornamental fish species for decorative purposes. It is made of glass for transparency and ornamental brightly coloured fishes used for their aesthetic values and recreational potentials are kept there. Recreation is a means of entertaining oneself after work; for the relaxation of ones mind, body and brain (Ayodele, 2002). The ornamental fisheries sector in Nigeria is still young, though young depends on wild collection of indigenous species and breeding of exotic species (Areola, 2001).

In Nigeria, the situation is different. The existing few marketers are scattered within Lagos and their impact is not felt in the economy, despite the abundance of over 300 species (Areola, 2004). The 1985 Western World Pet Supply Association (**WWPSA)** trade show in Long Beach California exposed many countries like Germany, USA, Malaysia, Peru, France and Singapore to the gains in ornamental fish trading who subsequently took advantage of these opportunities. Currently World trade in ornamental fish is estimated at about 1.8 billion US dollar per annum. Singapore, Malaysia, Hong Kong, Taiwan and Japan control about 60% of the world's ornamental fish product and export earnings while North America and Europe have introduced new dimensions of biotechnology, to produce genetically modified organisms They have succeeded in modifying the natural colours of the fish species to produce desired colour combinations as well as stronger and robust species (Areola, 2004). Nigeria ranks high in export of ornamental fishes amongst African nations such as Republic of Congo, Malawi and United Republic of Tanzania but has not fully exploited her stock of colourful, dark and lovely shaped ornamental fish species. About 100 species of ornamental live fishes have been identified to be regularly exported in Nigeria. There is no stock assessment of the different species but records show that ornamental fish export trade has been carried out in Nigeria for over 40 years.(Areola, 2004). Nigeria is particularly blessed with some species that enjoy high demand in the world market. These fish species are not brightly coloured but have characteristically distinctive shapes which make them unique. These include Longnose (Elephant nose), Reed and Butterfly. Long nose is available in large numbers in Nigeria during the dry season.

Butterfly and Reed are rare species found in our waters. Long nose is used as pollution indicator and also in entertainment centers and games resorts as souvenirs/gifts for its high market price. Reports have it that it is used in laboratories for the preparation of vaccines and anti-allergic ointment. The high demand of some of these ornamental fish species is because they are endemic to Nigeria and all known and reported attempts to reproduce them artificially over the years have failed. The opportunity therefore, exists to capitalize on this and dictate the market price. There is paucity of information on available resources. To date, there is no detailed resource survey to determine the species distribution or the production of exportable fish species in Nigeria.

The collection of these fishes from the wild is not sustainable. There are problems of transportation from collection points to point of exports, loss of time, and high fish mortality due to stress. Very few exporters are breeding some common species such as cichlids, catfish etc. Most often orders are cancelled for lack of the specific fish species. During the rainy season, the volume of water discharged and flooding does not allow for easy exploitation of these species of fishes. The roads leading to the remote areas where they are located are often not motorable resulting in little or no export during the rainy season. All export is through the Muritala Mohammed International Airport, Lagos, Nigeria. This curtails sourcing and exploitation of the vast abundant resource in the Northern and Eastern States. Other limiting factors include pricing and poaching of customers, losses or "dead on arrival" reports or antics of dubious customers, airline booking and airfreight charges and sourcing of finance for the export of ornamental fishes.

Nigeria has vast natural resources of tropical aquatic life which are high in demand abroad but here export of ornamental fish is estimated at only 5% of the total 20% potential of African's contribution to ornamental fish trade (Areola, 2004; Mbawuike & Pepple, 2003) took an inventory of the locally available fish species in Nigeria for export and discovered that most of the fishes exported are ornamental fishes apart from shrimps as Nigeria has not been able to meet up with the local demand for fish. Much work has not been done on ornamental fish in Nigeria; that is why this study was carried out. The objectives the study includes the following profiling the socio-economic characteristics of the ornamental fish traders, estimating the gross margin and ascertaining the constraints affecting ornamental fish marketing.

Methodology

The Federal Republic of Nigeria is the largest single geographical unit along the west coast of Africa and occupies a position where the western parts of the African continent meet at the equatorial Africa (Nigerian Year Book, 1970) lying between latitude 4^0 and 14^0 North and longitude 3^0 and 14^0 East. Nigeria's land area of about 92,377 million hectares is entirely within the tropical zone extending Northward from coastline for over one thousand and forty-nine kilometers. The major ornamental fish marketing activities is carried out mainly in Lagos State. Exportation of ornamental fishes are carried out from Lagos State. There are ornamental fish markets at Ikorodu town, and Epe town (Oja Oba), Ibiajengbede and Akio Village.The Nigerian Aviation Handling Company shed of the Muritala Mohammed International Airport is the only outlet for ornamental fish export.

Primary data was collected from One hundred and ninety six ornamental fish marketers with the use of a structured questionnaire. The ornamental fish species are from different states of the country. A two stages sampling approach was used to select one hundred and ninety six marketers from 386 respondents involved in the sale of ornamental fishes located in fourteen states in Nigeria [Lagos Ogun Edo Delta Bayelsa Abia Niger Ondo Nasarawa Rivers Cross River Akwa Ibom Kano and Benue].

Stage one was the stratification of the population into 3 strata; Fishermen, Exporters and Suppliers. Stage two involved the simple random sampling of 50% of marketers from each stratum. Data collected were analysed using descriptive statistics and gross margin analysis.

Results and Discussion

Socioeconomics characteristics

Table 1 shows the distribution of respondents by their socioeconomics characteristics across the three main activities of respondents. Majority of respondents (91.3 percent) were male and 47.4 percent fall between the age group of 41-60 years. Table 1 revealed that majority (79.1 percent) of respondents were married. Also, the results revealed that majority (85.2 percent) of the respondents have stayed long in the business for the range of 6-21years and above while about 33.2 percent of respondents have primary education level, 33.7 percent of respondents had no form of education.

Table 1: Distribution of the respondents by socioeconomic characteristics

	Fisherman	Exporter	Suppliers	Total	Percent
Distribution of the Respondents by Sex					
Female	10	2	5	17	8.7
Male	129	15	35	179	91.3
Total	139	17	40	196	100.0
Age group					
21-40	55	7	14	76	38.8
41-60	61	9	23	93	47.4
61 and above	23	1	3	27	13.8
Total	**139**	**17**	**40**	**196**	**100**
Marital Status					
Married	118	17	20	155	79.1
Single	14	0	17	31	15.8
Divorced	7	0	3	10	5.1
Total	**139**	**17**	**40**	**196**	**100**
Year of experience					
less than 5	19	5	5	29	14.8
6-10	23	4	4	31	15.8
11-15	15	3	8	26	13.2
16-20	37	2	16	55	28.1
21 and above	45	3	7	55	28.1
Total	**139**	**17**	**40**	**196**	**100**
Educational status					
None	61	3	2	66	33.7
Arabic	7	0	0	7	3.6
Primary	53	10	2	65	33.2
Secondary	18	4	24	46	23.5
Tertiary	0	0	12	12	6.1
Total	139	17	40	196	100

Source: field survey, 2016

Marketing Margin and Marketing Efficiency of Ornamental Fish

Gross Margin

The gross margin analysis was used to determine the profitability of the marketers in the study area as shown in Table 2. Result shows that the gross margin of suppliers is the highest throughout the four quarters with ₦9,288,876, ₦2,183,506, ₦4,054,671 and ₦2,611,749 for the first, second, third and fourth quarter respectively. The exporter earns the least gross margin (₦2, 186,677) which occurs in the third quarter. This may be due to the introduction of some marketing functions like transport cost, packaging etc. which the suppliers and fishermen can avoid. In the first three quarters, profit of the exporter increases but decreases in the fourth quarter. This could result from the fact that the fishermen supply to some of the consumers directly.

Profit

Table 3 presents the distribution of profit margin among fishermen, exporters and middlemen throughout the four quarters. In the first quarter (Jan-March), the profit margin of middlemen (₦9, 208,066) is the highest followed by that of the fishermen (₦1, 897,486) and exporters (₦2, 881,972). From the first quarter, there is an increase in the supply of fish which led to a higher profit margin for the fishermen which invariably reduces the profit margin of middlemen due to glut in the market but increases the profit of the exporters'. In the third quarter (July-Sept) the middlemen paid the same amount to the fishermen because of their pre-knowledge of the market which now reduces the profit margin of the latter and increases that of the former. And due to the higher supply, the price of fish dropped thereby reduced the profit margin of the exporters. In the fourth (October-December) quarter due to the trend of the production which has been affecting their profit margin, the fishermen reduce their production and this increases price which consequently increases their profit margin (₦1, 897,878). Efficiency of the exporters also increases but that of the suppliers decreases due to the fact that the supply falls and the exporters bought some of the fish from the fishermen directly.

Table 2: Average Gross Margin

	Fisherman			Middlemen			Exporters		
	GR(₦)	**TVC(₦)**	**GM(₦)**	**GR(₦)**	**TVC(₦)**	**GM(₦)**	**GR(₦)**	**TVC(₦)**	**GM(₦)**
Jan-March	1,949,027	8,651	**1,940,376**	9,405,175	1,16298.6	**9,288,876**	2,960,012	2,5781.35	**2,934,230**
April-June	1,654,959	1,9369	**1,635,590**	2,404,874	2,21368.7	**2,183,506**	3,517,108	3,1147.28	**3,485,961**
July-Sept	1,499,635	2,1572.73	**1,478,062**	4,313,848	3,47023.7	**4,054,671**	2,210,042	2,3364.39	**2,186,677**
Oct-Dec	1,949,572	2,6725.2	**1,924,712**	3,774,99.5	2,996,561	**2,611,749**	4,124,453	3,5930.88	**4,088,522**

Source: Computed from survey data (2016).

Table 3: Profit Margin

	Fishermen			Middlemen			Exporters		
	GM(₦)	**TFC(₦)**	**PM(₦)**	**GM(₦)**	**TFC(₦)**	**PM(₦)**	**GM(₦)**	**TFC(₦)**	**PM(₦)**
Jan—march	1,940,376	42,890	**1,897,486**	9,288,876	80,810	**9,208,066**	2,934,230	52,258.8	**2,881,972**
April-June	1,635,590	58,860	**1,576,730**	2,183,506	52,761	**2,130,745**	3,485,961	52,688.89	**3,433,272**
July-Sept	1,478,062	29,702	**1,448,360**	4,054,671	39,088.25	**4,015,582**	2,186,677	52,688.89	**2,133,988**
Oct-Dec	1,924,712	26,725	**1,897,878**	2,611,749	2,996,561	**2,632,666**	4,088,522	74,548	**4,013,974**

Source: Computed from survey data (2016)

Constraints to Ornamental Fish Marketing

Table 3 above shows the constraint encounter by Ornamental Fish marketers in Nigeria. The result shows that ornamental fishes are not available all the year round (seasonality) especially during the rainy season (between June and September) which is the breeding season for fishes. The fishes usually migrate to the shore where there are grasses. They hide under the grasses to feed and breed and are rarely seen. This accounts for 12.23% given by the respondent. Also the high cost of transportation(17.98%) reveals that transportation cost is high. The fishes are abundant in the villages, but not available in the cities where the shippers reside. The result in table 5 above reveal that the financial Constraints constitutes the highest percentage (30.94%) this suggest that a higher proportion of the respondent fishermen, suppliers and shippers do not have enough funds to have a very good facilities where they can keep the fishes until they can be sold. Banks do not give them loans because they trade in perishable goods.

Table 3: Constraints of Ornamental fish marketing

Variable	Frequency	Percentage
Seasonality	17	12.23
Low Participation of Farmers	13	9.35
High cost of Packaging materials	19	13.67
High Cost of Transportation	25	17.98
Financial Constraints	43	30.94
Naira Depreciation	14	10.07
Airline Problems/Multiple Taxation	8	5.76
Total	139	100

Source: field survey, 2016.

Conclusion

The fishermen, middlemen and exporters profit margins were positive for the period under study. Their marketing efficiencies were greater than one. There is freedom of entry and exit so the market can absorb more traders. A gradual trend towards effective regulation of activities and data collection has been established through the effort of the Federal Department of Fisheries. The sector is a potential developing source of foreign exchange earnings for the country, if strategic management policies are put in place. The sector also poses ultimate self-employment opportunities for the unemployed graduates most especially the fisheries graduates.

Recommendations

Based on the research findings of following recommendations were drawn.

1. The Federal Department of Fisheries do not have a formally established office at the Airport. There is need to establish these service in all airports include the certification of all exports, data collection and to ensure that all exports are covered by export permit which is a source of revenue to the Government from the fish harvested from the wild.
2. There is the need to carry out research in the breeding of these fishes by research institutes and Department of Fisheries in the universities.
3. There is a need to provide basic rural infrastructure to make the fishing communities where the fishes are bred to be accessible throughout the year.
4. There is a need for adequate monitoring so that the fraudulent customers abroad do not cheat Nigerian exporters. The exporters lose a lot of revenue as the banks dictate the exchange rate used in converting the proceeds of live fish export.
5. Loan should be given at a subsidized interest rate to the fishermen, suppliers and shippers in the study area. This will go a long way to alleviate their financial constraint.

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Analysing Levels of Market Orientation Among Cassava, Yam and Cococyam Producers in Abia State, Nigeria

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Abstract
Rural farming households in Nigeria have a long tradition of producing primarily for home consumption and they only rely on the markets for the foods they cannot produce on their farms. However, due to changing economic trends, particularly in the face of rising poverty among rural households, the pattern of household production was such that most of the rural household productions are sold to the market for income in order to meet the financial obligations of the households. This paper examines the level of household reliance on some market purchased root and tuber crops to sustain the farm family food needs in Nigeria. Primary data collected from 96 households randomly selected from 4 villages were analysed using a simple descriptive statistics. The study revealed that, the mean quantity sold for cassava (≈744kg) was the highest followed by the quantity consumed (≈286kg). However, Cassava and yam (76%) ranked highest in the percentage distribution of farmers, based on the type of root and tuber crop produced in Abia State. Therefore, the study concludes that there is a high level of market orientation of cassava and yam only by the rural households and it varies significantly across poverty levels in the study area.
Key words: Levels, Market orientation, Producers, Nigeria

Introduction
Understanding the changes in the share of food consumed by the rural farming households that is from the market in the face of changing socio-economic environment in which they operate is very important for several reasons (Onubuogu and Onyeneke, 2012). It, for instance enables us to see how the rural farming households, who have hitherto in the previous year's been able to meet substantial parts of their home consumptions of food from own production and how much of own food produced offered to the market have been affected by the changing social, economic and political environments in the country (Hernandex *et al*., 2007). Looking across poverty levels is also desirable so as to see the effect of household poverty on the degree of market orientation of both the poor and non-poor households (Weatherspoon and Reardon, 2003).

This paper is another effort in food demand studies with a view to understanding the level of market orientation of rural households and also to determine the appropriate points of policy intervention in food supply programmes. Furthermore, the role of markets in poverty and food intervention programmes needs to be better understood in the country in the face of changing socio-economic factors such as population, personal income levels, rapid rate of urbanization and tastes. Therefore, there is need for an assessment of the household food demand in the context of the role of the rural markets with a view to providing the empirical evidence required to understand the issues involved in designing an appropriate mix of policies for national and regional food and market planning (McCullough *et. al*., 2008). There are comparatively few published that have addressed the level of market orientation of cassava, yam and cocoyam producers in Nigeria.

Methodology

A purposive sampling technique was used in selecting a state and respondents. Abia state was chosen based on Cassava, Yam and Cocoyam production. Two local government areas was selected, four communities, four villages was also selected, finally, twelve cassava, yam and cocoyam farmers were selected based on the number of registered farmers in that area, making it a total of 96 farmers. However, these respondents comprised of producers, processors and marketers. Information were elicited from the respondents by means of focused group discussion, interview schedule and structured questionnaires. Data were analyzed using descriptive statistics, means and percentages.
3W

Results and Discussion

Socioeconomic Characteristics of the Respondents

Table 1.0: Socioeconomic characteristics of root and tuber crop producing households (n=96)

Variables	Frequencies	Percentage	Mean
Age			
25 – 34	1	1.0	
35 – 44	82	85.6	40
45 – 54	9	9.3	
55 and above	4	4.1	
Total	96	100	
Gender			
Male	44	45.8	
Female	52	54.2	
Total	96	100	
Marital status			
Single	9	9.4	
Married	87	90.6	
Total	96	100	
Educational Level			
Non-formal	0	0	
Primary	11	11.5	
Secondary	52	54.2	12
Tertiary	33	34.4	
Total	96	100	
Household size			
0 – 4	11	11.5	
5 – 10	81	84.3	6
11 and above	4	4.2	
Total	96	100	
Income			
1000 – 20000	14	14.7	12,620
21000 – 40000	14	14.5	
41000 – 60000	58	60.3	
61000 and above	10	10.5	
Total	96	100	
Total	**96**	**100**	

*Multiple Response
Source: Field survey data, 2016

The result in table 1.0 pointed out that 85% of the respondents were within the age range of 35-44 years with a mean age of 40 years. This implies that majority of the respondents were young and are ready to accept innovations, this in line with Poison and Spencer (1991). Dominance of female (54%) as against 45% male, suggests that root and tuber crop production is gender sensitive and requires more women than men, this is in agreement with Anyiro *et al* (2013). Also majority (90.6%) of the respondents were married also acquired basic education. This result is in line with the findings of Onubuogu and Onyeneke, (2012) who posited that education and training enhances farmers' productivity and market oriented production objective. Household size between 5-10 persons had 84.3% with the mean household size of 6 persons. The large household size is attributed to the need for cheap and dependable labour derivable for on-farm and off-farm activities. This findings is in agreement with the findings of Onubuogu *et al*. (2014) reported the most farm families have large household size between 5 to 10 persons with mean of 6 persons Furthermore, 60.3% of the respondents fell within the monthly income level of ₦41,000 - ₦60,000, with mean income of ₦45,620. This shows that market orientation of cassava, yam and cocoyam can be found to be very lucrative as the income of the farmers are higher than normal.

Levels of Market Orientation

Sampled respondents mentioned quantity of root and tuber crops sold in kg in the available markets. These were summarized and presented in Table 2.0

Table 2: Mean Value of the Allocation of Household Root and tuber Crop Productions (n=96)

Type of Root and Tuber Crop	Quantity Sold (Kg)	Quantity Consumed (Kg)	Quantity given as gift (Kg)
Cassava	743.5417	285.5208	70.41667
Yam	142.5521	88.33333	30.72917
Cocoyam	19.07292	6.020833	2.927083

Source: Field Survey, 2016

The pattern of household production was such that most of the rural household productions are sold to the market for income in order to meet the financial obligations of the households. Thus in agreement with Ololade and Olagunju (2013) report which earlier posited that income enhances productivity and promotes standard of living by breaking vicious cycle of poverty of small scale farmers. Some of the root and tuber crop produced goes into home consumption while some households gives their farm produce as gifts to friends and relatives. This is firmly rooted in the tradition of Africans that you have to be your brothers' keeper. Apart from gifts some other uses also occur in that category.

According to Eke-Okoro (2011), root and tuber crops play significant roles in the food economy of Nigerians. The root and tuber crops sector provides job opportunities and generate income for Nigeria.

Output Size of Cassava, Yam and Cocoyam Production

Figure 1.0 below shows the percentage distribution of farmers based on the type of root and tuber crop produced. From the result; planting cassava and cocoyam ranked lowest (4%), followed by Cassava only (20%) and the highest of them all is Cassava and yam (76%). Eke-Okoro (2011) also

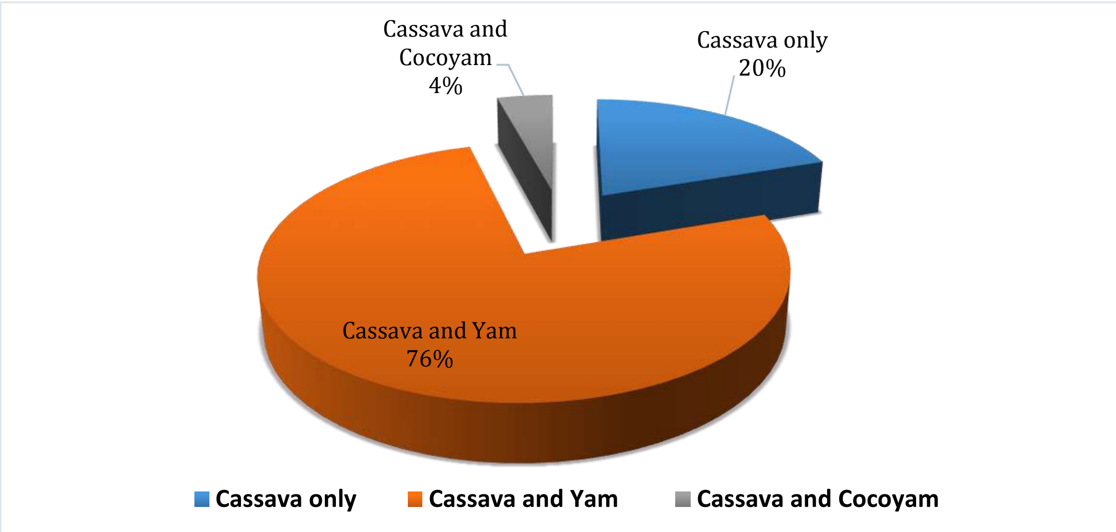

Figure 1: Percentage Distribution of farmers based on the type of root and tuber crop produced

posited that the importance of cassava in the lives of many Nigerians cannot be over-emphasized. As food, it comes first among the root and tuber crops despite the respect yam commands as a ceremonial crop. He also mentioned that the advantages of cassava as a candidate crop for hunger alleviation, poverty eradication and food security include tolerance to drought, low demands on soil nutrients, and capacity for providing good root. While yam (*Dioscorea spp)* are major carbohydrate staple and provides food for over 60 million people in West Africa. The importance of yam in Nigeria and indeed throughout the West African yam belt is not only for its role as a major food staple but also its sociocultural significance in the life of the people. Cocoyam (*Xanthosoma sp: Colocasia sp*) are also important staple in Nigeria ranking third among the root and tuber crops after cassava and yam. Nigeria is the world's largest producer of cocoyam and has an increased production output for more than 12 million tonnes. (NRCRI, 2000).

Conclusion

The study concludes that there is a high level of market orientation of cassava and yam only by the rural households and it varies significantly across poverty levels in the study area. Policies that would enhance the income generating activities of the rural households in the study area is desirable so as to enhance their food purchasing power, reduce food insecurity and reduce poverty relative to food. Furthermore, there should be an appropriate policy that would take care of the anticipated changes in the structure of food demand as poor households tends to become non-poor, when their income increase.

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Effect of National Special Programme on Food Security on Farmers' Income from Cassava Production in South-East, Nigeria

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Abstract
The study examined the effect of National Special Programme on Food Security (NSPFS) on farmers' income from cassava production in South-East, Nigeria. Specifically, it described the socio-economic characteristics of beneficiaries of NSPFS and determined whether NSPFS has increased farmers' income from cassava production in the study area. Multi-stage random sampling technique was utilized in selecting three hundred and sixty respondents (comprised 180 NSPFS participants and 180 non-participants) used for the study. Data were obtained with the aid of structured interview schedule and Focus Group Discussion, and analyzed using descriptive and inferential statistics, such as percentages, means and Z-test. The findings showed significant difference between incomes of participants and non-participants. The National Special Programme on Food Security increased farmers' income in South-East, Nigeria. The null hypothesis that there is no significant difference between the income of participants and non-participants in cassava production was therefore, rejected, while the alternative hypothesis was accepted. The study, therefore, recommended that more farmers should be encouraged by government to participate in the next phase of the National Special Programme on Food Security for increased food production, income and enhanced standard of living.
Keywords: Income, cassava production and National Special Programme on Food Security

Introduction
Agriculture is the most assured engine of development and a reliable key to industrialization in Nigeria. Therefore, its development is very important. This is because over 70% of its population live in the rural areas and derive their livelihood from agriculture, which comprises crop production, livestock, fishery and forestry, which accounts for about 35% of the total Gross Domestic Product (GDP) of Nigeria (CBN, 2010).
The major developmental challenges facing developing countries, especially Nigeria today is how to reduce the high level of poverty (Abiola and lofin, 2008). The World Food Summit in a meeting in Rome in 1999 estimated that 790 million people in the developing world do not have enough food to eat (Alamu *et al*., 2005). As a follow up to the summit, Nigeria, one of the 82 Low-Income Food Deficit Countries (LIFDC) requested for assistance under the FAO's National Special Food Security Programme (NSFSP). The pilot phase of National Special Programme on Food Security (NSPFS) in Nigeria started in Kano state, after a tripartite participatory review meeting of FAO, government, and beneficiary communities in March 1998 in Nigeria. The pilot phase focused on household and community level food security and livelihood issues.

In 2002, the programme was scaled up to the 36 states of the federation and Abuja, Federal Capital Territory at a cost of $45.2 million to be financed entirely by Federal Government of Nigeria (Onugha, 2008). The programme had three production/demonstration sites in each of the 36 states, one per senatorial district and one site in the Federal Capital Territory, which gave a total of 109 sites in the Federation. The first phase lasted for five year 2002 – 2006 and it tackled food security at national level by scaling up to all parts of the Federation. On seeing the achievement of NSPFS, and the need to improve small-scale production and sustainable agriculture for food security to reduce hunger rapidly, the government expanded the programme to six additional sites in each of the 36 states and two sites in Abuja, from 2007 to 2014. At this expansion phase the programme was renamed National Special Programme on Food Security (NSPFS) in 2007. It was expected that the programme would improve national food security, reduce pressure on national resources and reliance on food aid, and stimulate wider economic development. National Special Programme on Food Security (NSPFS) is farmer-driven as all activities are based on farmers' demands. The farmers' demand can be summarized as follows: timely provision of agricultural inputs and access to credit to acquire inputs.

The NSPFS mandate is to respond to these farmer-driven demands in a timely and coordinated fashion (Ihekoronye, 2013). Farmers in South-East Nigeria engage predominantly in cassava production. Cassava is one of the major staple crops, and is widely grown and consumed in Nigeria, and is inclusive in food security crops in the country. The implementation of National Special Programme on Food Security in Nigeria was expected to have enhanced farmers' income in South-East Nigeria, among other objectives. However, the programme with all the laudable objectives ended in 2014, but the extent to which it has increased farmers income is apparently unknown. It is in this regard that this study was conceived. Specifically, the study described the socio-economic characteristics of beneficiaries of NSPFS and determined whether NSPFS has increased farmers' income from cassava production in the study area.

Methodology

The study was conducted in South-East, Nigeria. The area lies within latitude 5^o 20' and 7^o 75' North, and longitude 6^o 85' and 8^o 46'East of equator and covers a land area of about 28,987 square kilometers, or 3.19 percent of the total land area of Nigeria. The Zone is made up of five states, namely, Abia, Anambra, Ebonyi, Enugu and Imo States. The states in the zone share similar characteristics (NPC, 2006). The zone covers the bulk of the Igbo-speaking ethnic territory or Igboland. The area lies mainly on plains under 200m above sea level. It is bounded on the south by Akwa Ibom and Rivers States, on the east by Cross River State, on the west by River Niger and Delta State, and on the north by Benue State (Monanu, 2000). The people of South-East Nigeria, especially the rural dwellers, engage mainly in subsistence farming. The major crops grown are cassava, yam, oil palm, cocoyam, rice, cocoa, maize, plantain, melon and okra. The respondents for the study were selected through purposive and multistage random sampling techniques from South-East Nigeria. There were four States that participated in the National Special Programme on Food Security in the zone. Three states namely Ebonyi, Enugu and Imo States were randomly selected from the four States that participated in the programme. Three agricultural zones were purposively selected from each of the selected states. This gave a total of nine agricultural zones. They were Okigwe, Orlu, Owerri in Imo State; Nsukka, Enugu, Awgu in Enugu State; Ebonyi North, Ebonyi Central and Ebonyi South in Ebonyi State. Two blocks were randomly selected from each of the selected agricultural zone; two circles were randomly selected from each of the blocks selected. Five participants of NSPFS were randomly selected from the list of participants in each of the selected circle, while five non-participants were randomly selected from the list of non-participants in the thirty-six selected circles. The lists of farmers were obtained from the respective circle extension agents. A total of Three hundred and sixty respondents were interviewed, comprised 180 NSPFS participants and 180 non-participants. Data were obtained with the aid of structured interview schedule and Focus Group Discussion, and analyzed using descriptive and inferential statistics such as percentages, means and Z-test. The objective on whether NSPFS has increased farmers' income from cassava production was realized by comparing the mean income of participants and non-participants. The null hypothesis that, there is no significant difference between the income of participants and non-participants in cassava production was tested at 5% level using z-test. The participants and non-participants indicated their income from cassava production in the last cropping season. Farmers' mean income from cassava production was computed and used to calculate the z-test by applying this formula:

$$Z = \frac{X_1 - X_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

Where Z = calculated value
$\overline{x_1}$ = Mean income of cassava for NSPFS participants
$\overline{x_2}$ = Mean income of cassava for non-participants
n_1 = Sample size of NSPFS participants
n_2 = Sample size of non-participants
σ_1^2 = Standard error for NSPFS participants
σ_2^2 = Standard error for non-participants

Results and Discussion

Socio-Economic Characteristics of Beneficiaries of NSPFS in South-East, Nigeria

The results in Table 1 show that the mean age was 43 years. It revealed that the beneficiaries were within the active and productive working class. This is in agreement with Ifenkwe and Umeh (2014) that active age of farmers is a positive factor to sustainable food production, poverty alleviation among farmers and improved agricultural extension. The mean household size of the beneficiaries of the National Special Programme on Food Security in south-East Nigeria was 7 persons. It is an indication that families in south-east Nigeria have large family members. The mean farming experience of the NSPFS beneficiaries was 13 years. This shows that most of the participants are young/or middle aged. Years of farming experience could give indication of the practical knowledge acquired in farming, especially the importance of participation in agricultural programmes like the NSPFS. On the average, the beneficiaries had secondary school education. This indicates that farmers in South-East Nigeria are literate. Educational attainment is a desirable condition for agricultural development, since it augurs well for adoption of new technologies and participation in agricultural programmes (Mazza *et al*., 2017).

Table 1: Socio-Economic Characteristics of NSPFS Beneficiaries in South-East, Nigeria.

Variables	Imo (n=60)	Enugu (n=60)	Ebonyi (n=60)	Pooled (n=180)	Mean $\overline{X}$
Age (years)					
21 – 30	5(8.3)	2(3.3)	1(1.7)	8(4.4)	
31 – 40	13(21.7)	9(15.0)	9(15.0)	31(17.2)	
41 – 50	40(66.7)	46(76.7)	45(75.0)	131(72.8)	43years
Above 50	2(3.3)	3(5.0)	5(8.3)	10(5.6)	
Gender					
Male	39 (65.0)	42(70.0)	43(71.7)	124(68.9)	
Female	21 (35.0)	18(30.0)	17(28.3)	56(31.1)	
Household Size (No.)					
1 – 5	10(16.7)	16(26.7)	15(25.0)	41(22.8)	
6 – 10	46(76.6)	39(65.0)	35(58.3)	120(66.6)	7 persons
11 – 15	4(6.7)	5(8.3)	10(16.7)	19(10.6)	
Farming Experience (years)					
1 – 10	17(28.3)	11(18.3)	11(18.3)	39(21.6)	
11 – 20	29(48.3)	32(53.3)	25(41.7)	86(47.8)	13 years
21 – 30	9(15.0)	10(16.7)	12(20.0)	31(17.2)	
31 – 40	2(3.3)	6(10.0)	7(11.7)	15(8.3)	
Above 40	3(5.0)	1(1.7)	5(8.3)	9(5.0)	
Farm Size (ha)					
Cassava					
< 1	20(33.3)	17(28.3)	15(25.0)	52(28.9)	1 ha
1 - 2	40(66.7)	43(71.7)	45(75.0)	128(71.1)	
Educational level					
No formal education	1(1.7)	3(8.3)	18(30.0)	24(13.3)	
Primary	15(25.0)	16(26.7)	5(8.3)	36(20.0)	
Secondary	34(56.7)	31(51.7)	32(53.3)	97(53.9)	12 years
OND	1(1.7)	5(8.3)	1(1.7)	7(3.9)	
HND	2(3.3)	2(3.3)	3(5.0)	7(3.9)	
BSc	5(8.3)	1(1.7)	1(1.7)	7(3.9)	
PGD	-	-	-	-	
Msc	2(3.3)	-	-	2(1.1)	
PhD	-	-	-	-	

Source: Field Survey, 2016. Figures in parenthesis are percentages

Farmers' income from cassava production

The study determined whether NSPFS has increased farmers' income from cassava production. This was realized by comparing mean income of participants and non-participants. The findings revealed that the National Special Programme on Food Security has increased farmers' income from cassava production. The participants realized mean income of N230,556 per hectare, while non-participants made mean income of N103,444 per hectare (Table 2). Better income gives better purchasing power and hence the improvement in living standard. This implies that the National Special Programme on Food Security has improved the living standard of those who participated in the programme. This is in line with the work of Panwal and Arene (2014) that the National Special Programme on Food Security increased income of participants in Plateau State. Increase in income is as a result of increase in yield which leads to improvement in the living standard of the farmers. Increase in farmers' yield, or income as a result of application of better technologies can be used to measure the success of an agricultural development programme because increase in yield translates to increased income, which further translates into improved standard of living (Agbarevo, 2010).

Table 2: Z-test significance of difference between cassava incomes of participants and non-participants

NSPFS	N	Mean	SD	t- tabulated	t-calculated
Participants	180	230,556	34.23093	1.96	1787.21**
Non-participants	180	103,444	21.74823		

Source: Field Survey, 2016. **Significant at 5% level.

Conclusion

The National Special Programme on Food Security has succeeded in increasing the income of participants which in turn translates to improved standard of living. Hence, it has partly met its mandate of increasing farmers' income in South-East, Nigeria. However, the effect of this increase in farmers' income does not seem to be very visible because of the small proportion of cassava farmers that participated in the programme. If all or majority of the farmers in the Region participated in the programme, the increase in farmers' income would have been achieved relative to cassava production in South-East, Nigeria. The study therefore recommended that more farmers should be encouraged by government to participate in the next phase of the National Special Programme on Food Security for increased income and enhanced standard of living.

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Efficiency of Snail Marketing in Rivers State, Nigeria

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Abstract

This research is aimed at evaluating the efficiency of the marketing of snail in two local government areas in Rivers-State, Nigeria (Ikwerre and Obio-Akpor). The sample size was 60 respondents, four markets in the selected local government areas were purposively selected because of the high presence of snail marketers, and primary data were obtained from well structured questionnaires. The data obtained were analyzed with the use of descriptive statistics, multiple regression analysis, marketing efficiency, costs and returns (using enterprise analysis). The result obtained from the socio-economic characteristics of the respondents showed that they contributed to the successful performance of marketing, types of snail marketed, were examined. The regression results showed that the selling price, market frequency, and gender were positive and significant at 5%, 1% and 10% respectively while the buying price was significant at 10% and negatively influencing the quantity of snail sold. Based on the econometric criteria R^2, F –Statistics, number of significant, and signs of significant variables as they conform to the a priori expectations. The efficiency of snail marketing evaluated showed that the snail marketing is efficient which concurs with the a priori expectations. The result of the costs and returns showed that the marketers incurred more costs but the business was profitable. The major constraints which limited the marketers were high transportation cost, financial difficulties, high cost of snail, low credit facilities. Based on the finding, more entrepreneurs should be encouraged to engage in snail rearing (Heliciculture) and marketing to reduce the buying price and make it more profitable.

Introduction

Snail are members of the *phylum mollusca*, they represent a large and varied group of shelled gastropod mollusks in the class *gastropoda* which contains at least 80,000 species and the second largest phylum in animal kingdom. The member of this group are found throughout the world, they are diverse in size and ecologically, bring terrestrial, freshwater or marine. Example of terrestrial species is *Helix pomatia* which is an edible snail (Cobbinah, 2008). The external characteristics of snail include a spiral shell, flattened foot and anterior head with prominent tentacle. When provoked, the snail can withdraw into its shell and in some cases, the shell opening can be closed by a horny or calcareous plate called aneperaulum. In Nigeria at large and in Rivers State most especially there are several types of snails that are good for food (edible) and been marketed for consumption, and this gives room for choice making in which a buyer decides the one to buy and consume, though the choice here, will depend on preference of buyers and his relations.

Snail as a meat is a rare delicacy for many because it provides a substantial source of protein. It is used to prepare a variety of meals including soup (Azeez, 2009). Protein from snail meat is said to be very rich in essential amino acid such as lysine, liucine, arginine and tryptophan, while being low in sodium, facts and cholesterol. Snail meat has a high nutritional and medicinal value. The snail meat can control hypertension and its blue liquid is used in stopping excessive bleeding from open wounds.

Importantly, snail has become a source of income capital, the iron and calcium content of snail contributes to the proper building/development of strong bones especially in babies. The snail meat aids in easy movement of foetus, easy delivery and good source of iron for pregnant and nursing mothers. Generally, its economic returns are high and are earner of foreign exchanged (CBDD, 2000).

Methodology

The sampling frame is the list of every member or units of the population from which a sample is drawn (Vitalis, 2005). With respect to the research work, the sampling frames covered include; Marketers of snail.

The selection of respondents was on multi-stage pattern and involved both purposive and random sampling techniques. The purposive sampling was used to select the six (4) markets under study for Obio Akpor the markets include Oil Mill, Rumuokoro and Mile 3. For Ikwerre the markets are Igwuruta (Ahia Odu). Simple random sampling was used in selecting the various participants (marketers) involved. The distribution of questionnaires to respondents was according to the area of study (Obio Akpor and Ikwerre). Obio Akpor had 45 while Ikwerre, had 15.

The sampling size was 60 respondents.

Method of Data Collection

Primary data was used for this study. The primary data were obtained through well structured questionnaires which were administered to the respondents, oral interview and personal observations. Relevant data collected include socio economic characteristics of the marketers, types of snail sold, cost and return of snail.

Method of data analysis

A number of analytical techniques were used in processing the data include descriptive statistics, multiple regression analysis, marketing efficiency model and cost and return model.

Model Specification

Formula for marketing efficiency= $\frac{\text{Total Revenue (₦)}}{\text{Total cost(₦)}}$

Multiple Regression Analysis

Explicitly, the function is stated thus,

$Y=b_0 +b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+b_8X_8+b_9X_9+b_{10}X_{10}+b_{11}X_{11}+b_{12}X_{12}+\mu$

Where;

Y= Quantity of Snail Sold (in paints)

X_1=Buying Price (₦)

X_2=Selling Price (₦)

X_3=Types of Snail (*Achantina achantina=1, Achantina maginata=2, Achantina fulica=3)*

X_4= Sources of Snail (wild=0, breeding =1)

X_5= Customers (number)

X_6=Market Frequency

X_7= Gender (female = 0, male =1)

X_8= Age (years)

X_9= Level of Education (years)

X_{10}=Household size (number)

X_{11}=Marital Status (married =1, single =0)

X_{12}= Sources of Fund (equity =1, debt =0)

μ= Error terms

b_0= Intercept

b_1- b_6=Coefficients to be estimate

Results and Discussion

The types and sources of snail traded in the study area

Table 1 shows the result of the types of snail marketed in the study area. This revealed that the major types of snail traded in the study area are *Achantina achantina, Achantina maginata, and Achantina fulica. Achantina maginata* had the highest percentage of 51.7 followed by *Achantina achantina* with 33.3% the least which is *Achantina fulica* has 15.0% with reason been that *Achantina maginata and Achantina achantina* command higher market price than Achantina fulica. And this concurs with Ajayi (1997) as noted that the Achantina fulica is of a low economic value as compared to *Achantina marginata and Achantina achantina* as these two command higher market price.

Table 1: the types of snail traded in the study area

Types	Frequency	Percentage (%)
Achantina achantina	20	33.3
Achantina maginata	31	51.7
Achantina fulica	9	15.0
Total	60	100

Source: Field survey data, 2017

Table 2: Distribution of the source where snails are bought by the respondents in the study area

Towns/Market	Frequency	Percentage
Igwuruta/Ahia Odu	6	10.0
PH Township/Borikiri	5	11.7
Elele/Ekekwu	4	6.7
Egeda/ Ekeoma	7	8.4
Yenegoa/Mbaima	33	55.0
Omuduoga/ Nkworakwor	5	8.4
Total	60	100

Source: Field survey data, 2017

Table 2 shows the various towns/ markets where snails where bought by the respondents. From the table it is obvious that the respondents bought more snails from Mbaima in Yenegoa with 55.0% while Ahia odu, Borikiri, Ekekwu, and Nkworakwor in Omuduoga had 10.0%, 8.4%, 6.7%, 11.7%, and 8.4% respectively. This shows that the major source of snail comes from Mbaima where snails are sold in their large quantity followed by Borikiki (Port-Harcourt Township). Ekekwu in Elele Town had the least percentage of 6.7%, which means that few of the respondents bought from the market.

The Factors influencing the Quality of Snail Traded in the Study Area

This is achieved using multiple regression analysis.

Table 3 Multiple Regression Results of Respondents

Variable	Coefficient	Error	t statistics
Intercept	0.033113	0.422858	0.078308
Buying price	-6.2E-05	2.99E-05	2.08136*
Selling price	7.92E-05	2.5E-05	3.05525**
Types of Snail	0.026449	0.058069	0.455483
Sources of snail	0.105558	0.155946	0.676886
Customers	-0.04036	0.097893	-0.41232
Market Frequency	0.49756	0.12138	4.098906***
Gender	34.0678	12.90867	2.639141*
Age	-0.06034	0.056765	-1.06299
Education	0.080412	0.066608	1.207246
Household Size	-0.00294	0.025158	-0.11673
Marital Status	0.042661	0.100597	0.424078
Sources of Fund	-0.05662	0.161305	-0.35103
R^{-2} 0.872			
R^2 0.913			
F-statistics 45.756			

Source: Field survey data, 2017 note: *** Significant at 1%,** Significant at 5%*Significant at 10%

From the result of the findings in Table 4.9 above, based on the adjusted R^2 (0.87%) and R^2 value (0.91%). This revealed that approximately 91% of the independent variables was accounted for by the dependent variable (quantity of snail sold).

Buying Price(X_1) was negative and significant at 10%. This indicates that there is a negative relationship between the buying price of snail and the quantity sold that is to say that an increase in the buying price of snail will lead to a decrease in the quantity of snail bought by the snail marketers. This conforms to a priori expectation as buying price generally affects the quantity of any commodity or goods sold. Due to the fact that marketers would not want to buy at a high price, thereby reducing the quantity sold. In other word, as the buying price increases the quantity sold decreases, as customers would not want to buy much when the price is high, with their income level remaining constant.

Selling Price (X_2) - Based on the estimated coefficient of the selling price which is positively related to the quantity of snail sold and significant at 5%. This indicates that as selling price increases the quantity of snail sold also increases. This is because price which generates income serves as motivation for marketers to buy and sell more of snails in the study area.
Market Frequency(X_3) – From the finding of this study, which also revealed that market frequency, is positively related to the quantity of snails sold and highly significant at 1%. This shows that an increase in the market frequency of respondents in the study area leads to increase in the quantity of snail sold. In other word, the more frequent marketers are in ensuring its availability, the more quantity they have for sale, thereby increasing their level of profit.
Gender (X_4) –From the result of the estimated coefficient of gender, which is positively related to the quantity of value added snail traded in the study area and significant at 10%. Means that as the gender increases the quantity of value added snail sold increases alongside, that is when more gender (male/female) marketers are involved in the business the quantity of snail sold is likely to increase.

Constraint limiting the efficiency of snail marketing
The Table as shown below presents the constraints limiting the efficiency of snail marketing in the study area.

Table 4 Constraints limiting the efficiency of snail marketing in the study area

Constraints	Mean	Standard deviation
High cost of snail	2.6667	1.72873
High cost of transportation	4.1333	89955
Financial difficulties	5.3667	3.55725
Low demand	1.5667	50401
Lack of credit facilities	1.7333	1.01483
Inadequate measurement	1.3000	46609
Theft	1.1667	37905

Source: Field survey data, 2017

From the result of the findings in Table 10 financial difficulty, high cost of snail, high cost of transportation and lack of credit facilities are major constraints to snail marketing efficiency. Having high limitation capacity followed by high transportation cost which is another constraint to snail marketing which concurs with Anebunwa, (2008) work in which he concluded that transportation is a major constraint in marketing, which he said accounted for nearly 80% of the total marketing cost.
Generally, lack of credit is one of the major constraints which the marketers faced as this is in agreement with Gyanendras (2013) as he stated that lack of credit, marketing intelligence, transportation are major constraints to marketing.

Table 5 Determination of efficiencies of snail marketing and the cost and returns in the study area

Items/Operations	Values (₦)	Percentage (%)
Average Purchase Price	2286000	
Average Selling Price	2675000	
Average Return from sale	2480500	
Variable cost		
Transportation	185000	
Loading / offloading	25900	
Feeding	72000	
Union dues	31000	
Total Variable Cost	313900	75.47
Gross Margin=TR- TVC	2166600	
Fixed Cost		
Depreciation on Equipment	102000	
Total Fixed Costs	102000	24.53
Total Cost	415900	100.00
Total Revenue	2064000	
Net Return from sales= Total Revenue(TR)-Total Cost(TC)		

Source: Computation from field survey data, 2017

From Table 5 above, the fixed cost of ₦ 102000 gave 24.53% of the total cost of ₦ 415900 and the variable cost of ₦ 313900 gave 75.47% of the total cost. The result shows that the marketers incurred higher variable cost than the fixed cost. That is to say in snail marketing, marketers incurred more cost in the day to day running of the business than in cost that do not change over time.
The Gross Margin which is gotten when total revenue is deducted from total variable cost showed to be ₦2166600 while the Net return, after all cost has been deducted was ₦2064000. This indicates that the business is profitable.

Table 6 Marketing efficiency of snail marketing
This is analyzed using marketing efficiency of snail respondents.
The result of the efficiency of snail marketing was computed, result presented thus,

Marketing Efficiency	Frequency	Percentage (%)
1.2 - 5.3	33	55.0
6.2 - 10.4	22	36.7
11.0 - 20.0	3	5.0
21.0 - 30.4	2	3.3
Total	60	100

Source: Field survey data, 2017

The computation of the marketing efficiency to determine the efficiency of snail marketing in the study area.
The result in Table 6 shows the marketing efficiency of marketers who fall within the efficiency ratio of 1.2-5.3 to be 55%, while those within 6.2-10.4 (36.7%), 11.0-20.0 (5.0%), and 21.0-30.4 (3.3%). This generally implies that there is efficiency in snail marketing in the study areas. Owning to the result gained from the analysis of data collected on the basis of snail marketing efficiency showed to be efficient and this concurs with the work of Odii and Obih (2000). Which states; the technical and economic efficiencies are efficient, if the operation /activity in which the ratios are computed is greater than one and inefficient when they are less than one.

Conclusion

The study in "Evaluating the Efficiency of Snail Marketing in Rivers- State, Nigeria" shows that snail marketing in the study area is profitable and efficient.

Also most of the constraints affecting the efficiency of the market were high cost of snail, lack of credit facilities, financial difficulty as well as transportation cost. The study is of the opinion that, if these constraints are taken care of the business of snail marketing will thrive the more in the study area.
Marketing of Snail is profitable with respect to the level of inputs used, to output obtained and it is a business which people should be encouraged to engage in mostly, for people who have no job. Snail marketing creates job opportunity for jobless individuals and serves as a means to earn a living. It does not necessarily owe to the fact that, it is a business for the uneducated; both the educated and non educated can venture into it. The marketing efficiency can be improved when those with formal education get involved thereby promoting the ability to evaluate new techniques and high tendency to adopt improved methods of technology.

RECOMMENDATION

The following recommendation are suggested to address the setbacks,
From the study it was obvious that women dominated the marketing of snail. It is pertinent to encourage males to get engaged in the marketing of snail so as to attain absolute efficiency and perfection in snail marketing. Owning to the fact that two out of the three types of snail traded in the study area command value and one out of the three showed to be of low economic value in order to improve upon this shortfall, agricultural scientist (breeders) are encouraged to venture into the business of raising snails in order to ensure that the one with lower economic value be cross bred so as to enhance its economic value. The choice of the source of snail can only be widened if agriculturalist incorporates snail production in the numerous agricultural activities.
From the findings, it was gathered that inadequate finance, credit facilities as well as high cost of transportation, and high cost of purchasing snail constitute major constraints in the course of marketing snail. I recommend that marketers of snail should form a cooperative society so as to ensure credit facilities and the government should come in to assist these marketers so as to improve upon the scale of operation by providing means by which they could gain access to credit facilities as these could help the marketers of snail to enhance and stabilize snail supply thereby achieving perfection in the business.

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Effect of Agricultural Information Utilisation on Food Security in (Egba And Yewa Zones) Ogun State

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Abstract
The effect of agricultural information usage on the sustainability of food production strategies is the focus of this study. Multi-stage and purposive sampling techniques were employed to select the study population from Egba and Yewa zones (Ogun Central and Ogun West). The random selection of 4 local governments was done from the zones followed by purposive selection of communities noted for intensive arable crop production in the study area. The findings revealed that majority of the arable crop farmers surveyed were above 30 years old and possessed elementary education. Agricultural information relevant to their farm operations were sourced from neighbors, fellow farmers, agricultural extension agent among others. The highest level of benefit was recorded among the farmers that had access to the full complements of available sources. ANOVA, Duncan Multiple Range test was used for analysis. The Mean score was significantly higher comparatively with those who did not access all the sources. The information utilized very frequently include Pest/Disease control, Weed Control crop processing, storage and marketing procedure. Changes perceived due to utilization include change in income and production level, adoption of new agricultural practice, and produce marketing strategies. Conclusively, strategic sustenance of food security and livelihoods could be enhanced through regular transfer or cross exchange of various crop production strategies particularly with the current global climate change challenges.
Key words: Agricultural information, Agripreneur, hunger, communication, poverty, security.

Introduction
The role of information sharing as an indispensable tool in all areas of human endeavor put to task the need to broaden agricultural production base through efficient innovation adoption system. Agricultural communication requires that key underlying factors must be considered to ensure effective information delivery, agricultural productivity and live transformation. Technology transfer in agriculture remains the pivot for development and this can be achieved through incorporation of appropriate information communication tools to disseminate and encourage eventual adoption of innovations. Yahaya (2003) noted that extension institutions and technology transfer programmes exist in almost every developing country yet the coverage of farm family is still limited. The quality of developing country extension programs is seriously questioned and the transfer of potentially beneficial new and underutilized technologies continues to lag. The involvement of various communication channels and strategies into extension programs with adequate funding will positively improve the impact of extension with its multiply effect on food security enhancement.

Agricultural Communication

Food and Agriculture Organization (FAO 2012b) identified communication among the key elements for global promotion of the use of food insecurity experience. The emphasis on communication as a potent tool for development is very important to achieve sustainable food security. Two-third of the population in Africa are employed in agriculture with the vast majority being smallholder farmers. Agriculture could provide one of the best pathways out of poverty but many farmers lack the knowledge and means to improve their farming practices, However digital technologies are beginning to change the trend (Pye-Smith 2018).

It is noteworthy that the peculiarity of information need of a farmer must be taken into consideration as a primary factor for its effective utilization Information transfer is very germane, reliable and efficient for technology transfer. Insufficient technology transfer initiatives have caused many producers to stick to sub-optimal practices and approaches. Small scale farmers need to be informed about the need to transit towards more nutrition-sensitive farming systems that will provide benefits in both economic and health related issues (Sania 2017) (Aliza and Daramola 2017).

The necessity of developing farmers and consumers capacity as major stakeholders in agribusiness through information sharing on agricultural innovation is very important for sustainability of food security and livelihoods.

Adedoyin *et al.* (2002) viewed agricultural extension as comprehensive program of services deliberately put in place for expanding and strengthening of prospective farmers, farm families and other rural economic operators. The goal of agricultural extension cannot be achieved without effective agricultural information utilization.

The objective of agricultural extension as proposed by Bokor (2005) include among others the dissemination of information relating to advanced technology in agricultural production which includes usage of improved seeds, methods of chemical and fertilizer application. The issues of farming systems, production and processing techniques are also involved among others. Communication process in agricultural extension is a functional organ for effective management of the various processes such as innovation decision process, teaching and learning processes among others. (Torimiro and Alfred 2003)

Agricultural Information Transfer

Agricultural information transfer is the heart of agricultural extension activities. Madukwe (2008) noted that the problems of lack of staff, poor staff mobility, quality of staff, weak linkages with agricultural research and weak financial support bugged agricultural extension work. The information transfer in agriculture is for empowerment using various communication strategies and tools with the ultimate goal of increasing food supply and breaks the poverty chain. The agricultural information system deals with issues relating to agricultural information generation, dissemination and utilization for agricultural development. It enables stakeholders in extension service to meet the agricultural needs of farmers from various backgrounds.

Demryurek *et al* (2008) noted that agricultural information interacts with agricultural productivity in variety of ways. It helps to improve productivity by supplying relevant reliable and useful knowledge. The judicious application of agricultural innovation knowledge is crucial to food security and livelihood sustainability because knowledge is power.

Kizilaslan (2006) opined that information system with effective feedback in the research--publishing—farmers' triangle is very crucial. The distribution of agricultural information to users and reciprocal user feedback is vital because it is the essential mechanism by which a consistently reliable and effective distribution of information can be maintained.

Challenges of Poverty and Sustainable Food Security

Food security is a situation in which people at all times have enough physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (CFS 2016). The issue of poverty is also a major challenge particularly with the upsurge of insurgence, internal and cross border conflicts and climate change effects that led to displacement of several rural settlers and farm families.

Globally 870 million people (one-eighth) suffered from chronic undernourishment in 2010-2012 (IFAD/FAO/WFP 2012). The figure of the poor rose from about 280 million in 1990 to 390 million in 2013 and since the accompanying leveraging measures are not in place hence the unbalance of population growth and poverty.

In Nigeria poverty declined by the first quarter of 2018 even though the International Monetary Fund (IMF) projected a growth of 2.1% by the end of 2018 (Kale 2018).

The rate of progress in poverty alleviation is uncertain and unstable because several factors and conditions are associated, while on the other hand it is essential to assess the level of hunger and food insecurity to be able to develop and monitor policies aimed at tackling the issue since no single indicator can measure or quantify the many dimensions of food and nutrition security.

The strategic objective 1 of Food and Agriculture Organization is contribution to the eradication of hunger, food insecurity and malnutrition (FAO 2012b). The establishment of Voice of Hungry Project in 2013 and its evaluation in 2017 was initiated by the FAO as part of efforts to fast track sustainability of food security. (FAO 2012(b)

Dimensions of Food Security

The physiological and socio -economic dimensions of hunger pose a conceptual challenge for measurement. According to Ballard (2013) FAO prevalence of undernourishment is one of the indicators selected to monitor progress toward achievement of Millennium Development Goals to reduce the proportion of people who suffer hunger to half by 2015.

It estimated the number of people who are likely not ingesting food to meet dietary energy needs based on national estimates using various parameters.

The strategic formulation and effective implementation of agricultural policy among other factors is crucial to provide solutions to food security issues at different levels thus providing access to cheap and varieties of nutritious food supply to all.

Methodology

Arable crop farmers were selected for the study using multistage sampling technique. Fifty percent of the four geopolitical divisions of Ogun State were selected while forty percent of the local government in each of these divisions were randomly selected leading to the choice of (Abeokuta North and Obafemi Owode Local governments) Two local governments in each division (Yewa North and Ipokia local governments.

Five communities were purposively selected from each local governments on the basis of high intensity of arable crop production. Finally, 25% of the arable crop farmers were covered by the survey using Snow-ball approach and eventually, were sampled for the study.

Results and Discussion

Socio Economic Characteristics and the Sustainability of Food Security Measures

Majority of the farmers were in the age range of 41-60 years. 30.68% and 27.5% constituted the age range of 41-50 and 51-60 respectively. This implies that the current drive for youth involvement in agriculture should be sustained. The Nigerian Youth In Agriculture, Youth Agripreneur programme, Children in Agriculture Programme (CIAP) and Youth Farmers' Club should be further encouraged to dramatically spur the interest of youths in agriculture.

The farm size of 1-3 hectares possessed by majority (35%) of the farmers was an indication that farmers need to be granted access to information on acquisition of large land area for farming either through outright purchase, leasehold etc. Sustaining food security and livelihood cannot be done without increase in land area under cultivation and increase in yield per hectare.

Sources of Agro Information

The sources of agro information as covered in the survey are: Fellow farmers, Electronic media, Extension Agents and Print media. The information sources sought by the farmers were done such that more than one information sources was utilized at a time by some of the farmers. All the sources of information identified in the study were utilized by the farmers to seek agro information based on their need as per time, resources and peculiar situations. About 36.8% of the farmers surveyed sourced information from three sources together Extension Agents, Fellow farmers and Electronic media. The educational level must have facilitated their choice and use of sources like Electronic Media, Print Media and Extension Agents.

Table 1: Sources of Agricultural Information

Fellow Farmers	14	8.7
Fellow Farmers Extension agents	11	6.9
Fellow Farmers, Ext Agent, Electronic Media	20	12.5
Fellow farmers, Ext Agent Electronic Media and Print Media	38	23.8
Fellow Farmers, Ext. Agent, Electronic Media Print Media And Commercial Agent	77	48.1
Total	160	100.1

Field Survey 2017

Table 2: Analysis of Variance (ANOVA) of Agricultural Information Utilization from different sources

Source of variation	Df	Sum of squares	Mean square	Fcal	Ttab	Remarks
Between groups	4	3050.997	762.749	78.445	2.43	Sig
Within groups	155	6409.747	41.353			
Total	159	9460.744				

In Table 2, the calculated F value in the Analysis of Variance Test was greater than the critical value (2.43) at P> 0.05. This shows that significant difference exist between some of the means. Field Survey 2017

Frequency of Agricultural Information Utilization

The result revealed that technical information on Crop disease /pest control was utilized more frequently with agro information on crop processing weed control and seeds sourcing. The information marketing and labour were also utilized than other information. The high level of utilization of information on Disease/pest control signals the farmers' response to the rise in waves of crop pests and diseases due to climate change impact. The agricultural information on marketing and labor were utilized more frequently by the farmers at 50.6% and 25.6% levels. This implies that agricultural information on marketing and labor were the needs of the farmer and must have affected the level of utilization. The pest/disease control and weed control information used frequent west analyzed using ANOVA test. The calculated Value in the ANOVA test (18.45) was greater than the critical value (2.43) at P>0.05 and this indicated significant difference between some of the Means. The Duncan Multiple Range test showed that 3 distinct homogenous subset exist in the sample.

Perception of Changes due to Accessibility and Utilization of Agricultural Information

The changes perceived through utilization of various agro information on production, processing and other services reflected on Awareness of innovations in agricultural practices, marketing of farm produce and increase in income. At another level access to labour usage, adoption of new farming techniques and access to labour and labour usage were the changes perceived due to the effect of information utilization.

Table 3: Perception of Changes due to Utilization of Agricultural Information

Change Perception	X_1 Strongly Agreed	X_2 Agreed	X_3 Undecided	X_4 Disagree	X_5 Strongly Disagree
Awareness of new agricultural practices	60 (37.5)	49 (30.6)	14 (8.8)	32 (20.0)	5 (3.1)
Income	42 (26.3)	82 (51.3)	22 (13.8)	14 (8.8)	-
Access to Land	9 (5.6)	74 (46.3)	12 (7.5)	45 (28.1)	20 (12.5)
Access to Labour	10 (6.3)	109 (68.1)	10 (6.3)	27 (16.9)	4 (2.5)
Usage Adoption New Farm Activities	10 (6.3)	78 (48.8)	18 (11.3)	36 (22.5)	18 (11.3)
Access to Loan and Effective Loan Use	8(5.6)	56 (3.5)	6 (3.8)	18 (11.3)	72 (40.5)
Change in Production level		28 (17.50	12 (7.5)	81 (50.6)	39 (24.4)
Marketing of Produce	49 (27.5)	61 (38.1)	11 (6.9)	19 (11.9)	25 (15.6)

Conclusion

Information were sourced mainly from Extension Agents, Fellow Farmers and Electronic media and Print media. The changes perceived eventually reflected on income generation, adoption of new production techniques, labour access and usage, access to land and better marketing of farm produce.

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Determinants of productivity among yam farmers in Enugu State, Nigeria

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Abstract
The study investigated the Influence of factors of production among yam farmers in Enugu State, Nigeria. A multistage random sampling was use to select 120 farmers. Structured interview schedule was used for data collection. Descriptive statistics and regression model were used for data analysis. The results showed majority (62.5%) of the farmers were male while that of the female counterparts were 37.5%. About 51.7% of the farmers were married while 23.3% of farmers were single. The average mean age of the farmers was 44 years while the average mean years of farming experience were 11 years. The average mean household size of the farmers was 8 and 54.2% of the farmers were full time farmers. Similarly, majority (37.5%) of the farmers used hired labour while the average farm size cultivated by the farmers was 1.08ha. Out of the fourteen variables investigated, only eight variables were found to be statistical significant as regards to the influence of personal and socio-economic characteristics of farmers on yam production in Enugu State. They were sex (P=0.000), farm size (P=001), farming experience (P=003), soil fertility (0.000), income (0.002), access to extension service (0.004), cost of seed yam (0.001) and constraint perceived (0.007). The major constraints militating farmers against yam production were: high cost of seed yam (2.86), high cost of labour (2.95), low soil fertility (2.89), poor use of improved varieties (2.65), poor road network (2.58), pest/disease infestation (2.06), inadequate extension service (2.28), and drought factors (2.45). This study recommended that agro input such as yam seedlings should be made available to farmers thereby subsidizing them in a way that can be affordable to farmers. More extension workers should be recruited, remunerated and posted to rural areas as to get more farmers acquainted with innovations as well as the farming practices available at their usage.

Key words: Yam farmers, influence, and factors of production

Introduction
Yam is in the class of roots and tubers that is a staple of the Nigerian and West African diet. Babaleye (2003) observed that yam contributes more than 200 dietary calories per capita daily for more than 150 million people in West Africa while serving as an important source of income to the people. Interestingly, yam is categorized as chief among the major staple food of Nigerians on account of its indispensability (Oluwatusin and Shitu, 2014). Its highly produced in all parts of the country. Also, national food security is strengthened due to variability in production in different part of the country. This was so due to differences in season as a result of different vegetation which characterized farming system of the nation.
In Enugu State Nigeria, yam cultivation still depends largely on labour intensive, traditional hoe-cutlass techniques of production. Many aspects of production like clearing, planting, weeding, staking and harvesting require considerable inputs of labour. However, as rural labour becomes more scarce and expensive, and the price of inputs increases, the cost of yam in the market increases making it a luxury food rather than a staple (Hahn, Osiru, Akoroda & Atoo, 1993).
Nigeria is the world's largest producer of yams, accounting for over 70–76 percent of the world production (Wikipedia, 2011). FAO (2008) reported that Nigeria produced 18.3 million tonnes of yam from 1.5 million hectares, representing 73.8 percent of total yam production in Africa. According to 2008 figures, yam production in Nigeria has nearly doubled since 1985, with Nigeria

producing 35.017 million metric tonnes with value equivalent of US$5.654 billion (FAO, 2008). Also in West Africa, average statistics has shown that 95% of the world's output of 34 million metric tonnes (mmt) of yam in 2001was produced and Nigeria alone produced 75% of this total Output.

Awoniyi *et al.* (2006) in Oluwatusin and Shitu (2014) reported that in many yam producing areas of Nigeria, it is said that yam is food and food is yam. This shows that, the importance of yam to the existence of the people cannot be overemphasized. It is therefore worthy of note that yam to an average Nigerian man is indivisible. Moreover, researchers over the years have been able to look into values of yam health wisely. Ekp, Idiong and Chinemerem (2000), Oluwatusin and Shitu (2014) reported that Yam tuber contain pharmacologically active substances such as dioscorine, saponin and sapogenin. Dioscorine which is the major alkaloid in yam is medicinally a heart stimulant while saponin has a bioactivities and therapeutic uses. Saponin has been used as adjuvant in vaccines as well as together with immunotoxins as cure for leukaema, lymphoma and other cancers. It is also used in preparation of traditional medicine (Oluwatusin and Shitu, 2014). Also, yam tuber is a good source of energy mainly from their carbohydrate contents since it is low in fat and protein. However, yams tend to be higher in protein and minerals like phosphorus and potassium when compared with sweetpotatoes though the latter are richer in vitamins A and C (Consultative Group on International Agricultural Research, CGIAR, 1997). Also, it has been reported that yam is a good source of industrial starch whose quality varies with species.

In spite of significance of yam production in the economic and socio-cultural aspect of Nigeria as a nation, it has not been accorded the needed attention (Orkwor and Aseidu, 1999). This was reflected in the fall in output percentage growth rate of yam from 42% in 1990 to 16.3% in 2001, despite the increase in land devoted for the production of crop from 120 million hectares in the same period (Federal Ministry of Agriculture, 2001). In spite of the tremendous importance of the yams in the West African sub region, Babaleye (2003) affirms that the crop has hitherto been neglected in policy decisions related to research, crop production and marketing. Most of the efforts of the policy makers and researchers have been concentrated on cash crops and the more familiar crops (Oluwatusi and Shitu, 2014).

According to Akoroda and Hahn (1995) in Oluwatusi and Shitu (2014), the production of yam in Nigeria is grossly inadequate and cannot meet the ever-increasing demand for it under present level of input use. One of the major factors that contribute immensely to this fallout in productivity of yam over the years is the problem of production inefficiency. This is so as production efficiency is directly related to increase in production. In view of these, it is therefore imperative to assess the socio-economic factors that influence the performance of yam farmers in Enugu state, Nigeria. The specific objectives are to examine the influence of personal and socio-economic characteristics of farmers on yam production in the study area.

Materials and Methods

The study area is Enugu State, which is one of the five States in South eastern Nigeria. The State lies between latitude 5^0 56'N and 7^0 06' N and longitude 6^0 53' E and 7^0 55'E. The State occupying a land area of about 802,295km^2 (Ike and Inoni, 2006**)**. The State shares boundaries with Abia, Imo, Ebonyi, Benue, Kogi and Anambra. The estimated population of the state in the last population census is 3,267,837 (NPC, 2006). It is characterized by small farm holdings with yam and cassava as the dominant crop. Enugu State comprises 17 Local Government Areas (LGAs) with three agricultural zones, namely Awgu, Enugu and Nsukka. Two agricultural zones (Enugu and Nsukka) were selected out of the three zones in the state .Two LGAs were selected from each of the zones making it a total of four local governments that were used for the research. The selected local government areas are Nkanu East, Nkanu West, Udenu and Uzo-Uwani. From each of the LGA, three communities were randomly selected giving a total of 12 communities. From the list of yam farmers prepared for each of these communities, 10 farmers were randomly selected giving a total of 120 farmers used for the study. Structured interview schedule was used for data collection. Frequency, percentage, mean scores and regression model were used for data analysis.

Measurement of Variables

To ascertain the influence of personal and socio-economic characteristics of farmers on yam production in the study area, regression model was used.

Y = a+b1x1+b2+x2+b3x3+b4x4…….b14x14 + u

Y = yield of yam (measured in kg/ton)
a = constants term
b1 –b14 = regression co-efficients
x1 = Age (measured in years)
x2 = Sex (dummy variable, male = 1, female = 2)
x3 = Education level (measured by years spent in school)
x4 = Household size (measured by the number of people living under one roof)
x5 = Member of social organization (member = 1, non-member = 2)
x6 = Farm size (measured in hectare)
x7 = Farming experience (measured in years)
x8 = Trading received (Received training = 1, non-training = 2)
x9 = Soil fertility (dummy variable for good soil = 1, poor = 0)
x10 = income of the farmers (measured in Naira)
x11 = Extension contact (access to extension service = 1, No access = 0)
x12 = Access to credit (access = 1, No access = 0)
x13 = Farming practice (shifting cultivation = 1, No shifting cultivation = 0)
x14 = perceived constraints (very serious = 3, serious = 2, no serious = 1)
u = error term

Results and Discussion

Entries in Table 1 show that majority (62.5%) of the farmers were male while that of the female counterparts were 37.5%. These imply that male participated more actively than their female partners in the activities of yam production in Enugu state. However, the participation could be attributed to be gender specific in the sense that culture restricts female from participating fully in the activities of yam production in some communities. Based on these, Oguntate, Thompson and Ige (2010) said that yam production was dominated by men in Oyo state. About 51.7% of the farmers were married while 23.3% of farmers were single. The very high percentage of the married yam producers could be attributed to the fact that respondents require helping hands to carryout tedious process of yam production. This is also an indication that most farmers depends on family members as cheap source of labour. The average mean age of the farmers was 44 years. This implies that young people of active productive age dominated the farming activities of yam production in the study area. This could also help to increase their productivities. The average mean household size of the farmers was 8 while 54.2% of the farmers were full time farmers. This implies that farmers have large family size and this is expected to influence yam production positively. It has been shown that decisions are made by the farm family, since the various farming operations are carried out by the members of the family. Also the family size constitutes a major source of labour available in yam production.

Similarly, majority (37.5%) of the farmers used hired labour while the average mean years of farming experience were 10 years. This implies that farmers had long period of farming experience which could increase their experience as regards to yam production. Greater proportion (52.5%) of the farmers acquired land by rent while about 47.5% of the farmers cultivated less than 5 hectares. The average farm size cultivated by the farmers was 1.08ha. This implies that farmers in the study area are still small-scale farmers. This finding agreed with Udemezue and Onwuneme (2017) who said that farmers in Anambra state were small scale farmers. Moreso, majority (52.5%) of the farmers completed secondary school while about 33.3% of the farmers completed primary school. Since the greater proportions of the farmers were literate, this could make them integrate educational knowledge in their values and farming system to increase production. The farmer's educational level is expected to have a positive influence on the adoption of improved technologies such as farm mechanization, fertilizer usage, agro-chemical, high yielding seeds variety which should have high potentials to increase farm productivity. Hence, education is seen as one of the key factors to adoption of agricultural technologies. About 64.2% of the farmers belonged in social organization. Majority (58.3%) of the farmers had access to credit while 67.5% of the farmers did not have access to extension service therein. In the same vein, greater proportions (37.5%) of the farmers earned between N300,000 – 350,000 as income while about

1.7% of the farmers realized less than N50,000 from yam production. The average mean income of the farmers was N270,000.

Table 1: Distribution of farmers according to personal and socio-economic characteristics

Variables	Frequency	Percentage	Mean
Age:			
21-30	20	16.7	
31-40	35	29.2	
41-50	58	48.3	44
51 and above	7	5.8	
Sex:			
Male	75	62.5	
Female	45	37.5	
Marital Status:			
Single	28	23.3	
Married	62	51.7	
Divorced/Separated	15	12.5	
Widowed	15	12.5	
Household Size:			
1-5	35	29.2	
6-10	55	45.8	8
11-15	30	25.0	
Educational Level:	3	2.5	
No formal education	40	33.3	
Primary school completed	63	52.5	
Secondary school completed	10	8.3	
OND/NCE	4	3.3	
HND/Degree			
Occupation:			
Farming	65	54.2	
Trading	35	29.2	
Civil servant	20	16.7	
Source of Labour:			
Family labour	15	12.5	
Hired labour	45	37.5	
Exchange labour	15	12.5	
Family and hired labour	10	8.3	
Family and exchange	5	4.2	
Family, hired and exchange	30	25	
Farming Experience:			
1-10	55	45.8	
11-20	50	41.7	11
21-30	10	8.2	
31-40	5	4.2	
Land Acquisition:			
Inherited	63	52.5	
Rented	37	30.8	
Purchased	20	16.7	

Table 1: (cont'd)

Income (₦):			
250,000	2	1.7	
50,000-100,000	10	8.3	
100,000-150,000	15	12.5	
200,000-250,000	2	1.7	70,000
300,000-350,000	45	37.3	
400,000-450,000	34	28.3	
500,000 and above	12	10.0	
Farm Size:			
1-5ha	57	47.5	
6-7ha	43	35.8	1.08
7-8ha	20	16.7	
Social Organization:			
Yes	77	64.2	
No	43	35.8	
Extension Contact:			
Yes	39	32.5	
No	81	67.5	
Access to Credit Loan:			
Yes	70	58.3	
No	50	41.7	

Source: Field Survey, 2018.

The results of regression model in Table 2 of the independent variable (sex, age, household size, educational level, social participation, farm size, training received, farming experience, soil fertility, income, access to extension service, access to credit, cost of seed yam and constraints received) on determinants of yam production by farmers shows that a strong correlation (R = 0.875) exists between dependent variable and independent variables. These variables were able to explain 77% of the variation in the influence of personal and socio-economic characteristics of farmers on yam production (R^2 = 0.769). Adjusted R^2 also supported the claim with a value of 0.672 or 67%. This implies that the independent variables explain the behavior of the dependent variable at 67% level of confidence.

Out of the fourteen variables investigated, only eight (8) variables were found to be statistical significant as regards to the influence of personal and socio-economic characteristics of farmers on yam production in the state. They are sex, farm size, farming experience, soil fertility, income, access to extension service, cost of seed yam and constraint perceived.

Sex: Sex is one of the factors influencing yam production in the study area. This could be the fact that yam production is labour intensive and requires a substantial energy and time of which majority of women could not cope with. This finding is in line with the results of Okwor (1998); Udemezue and Onwuneme (2017) which described yam production as a token of masculinity.

Farm Size: This is another factor that influences yam production in the findings. Farmers with large farm size are more likely to produce more yams than those with small area of land if all things being equal. Therefore, the positive influence of farm size implies that the larger the farm size, the more productivity from the farmers. This finding agreed with the findings of Oguntate et al (2010) which saw farm size and farming experience as the determinants of yam production in their study.

Farming Experience: Years of farming experience were positive and significantly influenced yam production in the study area. This implies that the contribution of explanatory variable is inversely proportional to dependent variables. Therefore, the more farming experience farmer had, the higher the productivity of yam.

Soil Fertility: Level of soil fertility has a negative influence of the determinants of yam production in the study area. This indicates that the more fertility land is, the higher the productivity of yam provided that all things being equal. On the other hand, it also shows that the lesser the soil fertility, the lower the productivity of the crop. This finding is in consonance with Udemezue and Onwuneme (2017) who saw soil fertility as the determinants of yam production in Anambra state.

Access to Extension Service: Extension contact has a negative influence on the yam production. The positive sign implies that frequent contact with extension agent by the farmers gives them the opportunity to know about the use of new farming techniques to increase their production while negative contact with extension agent will affect their production due to the fact that farmers may have missed information or the basic inputs needed to increase production. Therefore, regular contact with extension agent makes farmers being aware of new technologies and how they can be applied to improve their livelihood. This finding is in line with Mutain, Agunda, Muluvi, Kibert and Maina (2013) who said in their study that access to extension played a positive role in the activities of sweetpotato production in Vihiga Country, Kenya.

Income: This is another factor that influenced yam production in the study area. Income generated from yam helps to improve farmers' living standard. Increase in income by 1% can as well cause the probability of farmers engaging in yam production as far as there is cash flow in the business. The increase in cash resources will make the farmer invest more on yam production. Therefore high income from yam production is important for an increase in the overall amount of involvement and adoption of improved technologies. Based on this, Mutai *et al* (2013) saw income as a variable that influenced socio-economic characteristics of farmers in Vihiga Country, Kenya.

Cost of Seed Yam: Source of seed yam is positively influenced the intensity of adoption of yam production practices in the study area. Access to farm inputs such as seed yam makes farmers engaged significantly into yam production technologies. Farmers who have access to agro-inputs tend to adopt technologies more readily than those who have not. This implies that those with access to farm inputs are likely to involve more in yam production than those who have not. Hence, high cost of seed yam has been limited some farmers from yam production.

Perceived Constraints: Constraint is one of the factors influencing socio-economic characteristics of the farmers on yam production. It has a negative influence which implies that is inversely related to the dependent variables. Therefore, the higher the perceived constraint by the farmers, the lower the rate of yam production in the study area. Therefore, for production rate to be maintained with respect to yam production, constraints have to be less effective.

Table 2: Regression model for the influence of personal and socio-economic characteristics of farmers on yam production in Enugu State

Variables	Unstandardized Coefficients B	Standard Error	Beta	Standardized Coefficients T	Significance
Constant	1.676	0.872	-	3.668	0.005
Sex	1.535	0.406	0.462	3.809	**0.000**
Age	0.005	0.014	0.023	0.370	0.896
Household size	0.054	0.035	0.137	0.563	0.106
Educational level	0.206	0.084	0.185	2.549	0.618
Social participation	0.370	0.254	0.114	1.352	0.68
Farm size	1.274	0.155	0.723	8.827	**0.001**
Training received	0.046	0.266	0.012	0.174	0.816
Farming experience	1.767	0.435	0.374	4.050	**0.003**
Soil fertility	-1.636	0.408	-0.452	-3.978	**0.000**
Income	1.635	0.507	0.553	4.987	**0.002**
Access to extension service	-1.633	0.408	-0.543	-3.987	**0.0004**
Access to credit	-0.817	0.0341	-0.223	-2.331	0.074
Cost of seed yam	1.734	0.507	0.466	3.897	**0.001**
Constraints perceived	-0.843	0.385	-0.254	4.948	**0.007**
R = 0.875, R^2 = 0.769, Adjusted R^2 = 0.672					

Source: Field Survey, 2018.

Table 3 shows the constraints faced by the farmers in the study area. The major constraints militating farmers against yam production were: high cost of seed yam (2.86), high cost of labour (2.95), low soil fertility (2.89), poor use of improved variables (2.65), poor road network (2.58), pest/disease infestation (2.06), inadequate extension service (2.28), and drought factors (2.45). Other constraints were lack of finance, inadequate farm inputs, high perishables of the product, age of the farmers, poor health status of the farmers, poor income from the crop and large farm size. Their finding agreed with Oluwatusin and Shitu (2014) who saw high cost of labour as the constraint working against yam production in Nigeria.

Table 3: Distribution of respondents according to constraints faced in yam production

Variable	Mean	SD
Lack of finance	1.33	0.454
High cost of seed yam	**2.86**	0.623
Inadequate farm inputs	1.58	0.711
High cost of labour	**2.95**	0.758
Low soil fertility	**2.89**	0.734
Poor use of improved yam varieties	**2.65**	0.63
Poor road network	**2.58**	0.53
High perishability of the product	1.30	0.52
Pest/disease attack	**2.06**	0.75
Inadequate extension service	**2.28**	0.84
Age of farmers	1.18	0.45
Poor health status of the farmers	1.50	0.71
Poor income from the crop	1.35	0.82
Large farm size	1.28	0.51
Drought factors such as rainfall, temperature and solar radiation.	**2.45**	0.76

Source: Field Survey, 2018. Cut-off-point = 2 and above. SD = standard deviation

Conclusion and Recommendations

Out of the fourteen variables investigated, only eight variables were found to be statistically significant as regards to the influence of socio-economic characteristics of yam farmers in the study area, they were: sex, farm size, farming experience, soil fertility, income, access to extension service, cost of seed yam and constraints perceived. High cost of labour, low soil fertility, poor use of improved yam varieties, poor road network, pest/disease infestation, inadequate extension services and drought factors were perceived by the farmers as serious constraints working against yam production in the study area. Sequel to the above, this study therefore recommends that:

High cost of inputs such as seed yam has been identified as one of the major constraints to yam production. Therefore, effort should be made to make agro inputs available to farmers thereby subsidizing them in a way that can be affordable to farmers.

There should be more investment on yam production since it serves as self-employment especially for men and this will help to fight agricultural imbalance and shortage of employment in Nigeria. Training among farmers should be encouraged, regularized and implemented by the stakeholders in order to update the minds of the farmers on agricultural innovations. Extension agents should educate farmers on the alternative use of organic agriculture and soil management practices as to retain soil fertility. Stakeholders including nongovernmental organization at all levels should intensify effort to rehabilitate all the existing roads leading to farming field in order to be accessible by the farmers. More extension workers should be recruited, remunerated and posted to rural areas as to get more farmers acquainted with innovations as well as the farming practices available at their usage.

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Analysis of Cassava Marketing In Ivo Local Government Area of Ebonyi State, Nigeria

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Abstract
The study was on the analysis of cassava marketing in Ivo LG of Ebonyi State, Nigeria. Data were collected from randomly sample of 80 cassava marketers in the area, using a structured questionnaire. The study revealed that most of the cassava marketers had a secondary education (67.9%). The investigation also revealed that marketing of cassava is mostly undertaken by females (82%). The result showed that married people (71.2%) were primarily involved in the marketing of cassava. The study revealed that cassava marketing is operated in a competitive market environment and the marketing margin obtained by an average cassava marketer is 31%. Cassava marketing is a profitable venture in the study area. It was also revealed that a higher percentage of cassava traded in the study area was primarily obtained from the farmers. Majority of the respondents (72.5%) do not belong to the cassava marketing association. Transaction cost ((-4.727) and Marketing Experience (4.010) of cassava marketer in the Ivo L G A were statistically significant at varied probability levels. More specifically gender and Transaction cost were negative and highly significant at the 1% level of probability. This implies more female in the trade will lead to a corresponding decrease in transaction cost. This conforms with a prior expectation that household activities make the women to have less attention to the trade and the bulky nature of the trade will lead to a decrease in market efficiency. Transaction cost was negative and significant at 10% level of probability. This implies that any increase in transaction cost will decrease marketing efficiency. The study calls for policies that will assist marketers in reducing transaction costs through the provision of infrastructures.
Keywords: Cassava and Marketing

Introduction
Cassava (Manihotesculenta) is an important food crop in the tropics.It is a significant carbohydrate staple. According to FAO, the tropical root crop cassava is the third most important source of calories in the tropics, after rice and corn (FAO 2002). The use of cassava as a source of ethanol for fuel, energy in animal feed, and starch for the industry is increasing (Kolawole and Agbetoye (2007); Kehinde (2006). As a food crop, cassava is grown in all the agro-ecological zones of Nigeria (Graffham *et al.* 1998). Fresh cassava does not store well because of its high moisture content. Therefore cassava is usually processed traditionally to obtain different relatively shelf stable intermediate and final products for various food applications. These products include "*gari*", a roasted, fermented cassava meal, "*agbelima*" which is a fermented cassava mash, and the dried cassava chips known as "*kokonte*" which is further processed into cassava flour. *Tapioca* is a minor product or by-product from cassava processing. For industrial use, cassava is processed to obtain *starch*. Cassava can be used as a feed ingredient for animals such as cattle, pigs, poultry, sheep, goats, and fish. While the majority of cattle and small ruminants still rely extensively on grazing, the poultry and pig industry have been identified as significant potential markets for dried cassava as a raw material for feeds. In particular, it is estimated that layer hens absorb about 80 – 90% of animal feed specific, rations in Nigeria. The broiler sub-sector is relatively small mainly due to overseas imports of poultry meat. The bulk of the poultry feed is mixed on-farm by medium to large-scale farmers, with commercial feed millers often supplying feed concentrates. Cassava is an extremely

vital crop, not only in the domestic market but also to the export market. Domestically, it is not just a primary source of income, but it is a stable crop vital to food security. (Bolarinwa and. Oladeji, 2009) The Objectives of the study are to Analyze the Cassava Marketing in Ivo Local Government Area of Ebonyi State, Nigeria and Identify determinants of transaction costs

Methodology

The study was carried out in Ebonyi State. The study covered one out of the three agricultural zones in Ebonyi state. Multistage random sampling technique was used in the selection of Agricultural zones and respondents. One local government area was randomly selected from the agricultural chosen zones. Two markets were randomly selected from each L G A. The markets chosen were: Nkwogbo market in Umuogbo and Orie Akaeze Ukwu in Akaeze Ukwu. Forty cassava marketers were chosen randomly from each chosen market. This gave a total number of 80 cassava marketers. The primary data were collected with structured questionnaire. The data collected were analysed using descriptive statistics such as frequency, and multiple regression model

Results and Discussion

Table.1 shows that more females (82.0%) participated in cassava marketing than males (18.0%) in the study area. Also, the result indicates that the majority of cassava marketers are relatively young individuals (45%) who are in their youthful age (34-43 years). The result indicates that transaction and participation in cassava marketing were dominated by married people (71.0%). This implies that the trade is a source of income to many families from which they meet their basic needs. The result reveals that majority of the respondents (46.0%) had household sizes of 5-8 persons and 93 .34% of the cassava marketers had one form of education or another while 6.66% had no formal education. This shows that literacy level was high amongst them and could enhance marketing technology. The level of education was identified to increase the marketing efficiency and the marketing techniques and this was in line with the findings of Obasi, (1991).

Factors Influencing Transaction Costs of cassava Marketers:

In analysing the factors that influenced the transaction costs incurred by cassava marketers in the study area regression model was used. The result of the analysis for the cassava marketers is presented in Table 2; the double log function was selected as the lead equation based on the R^2 value which is high at 73% and the number of explanatory variables that was significant. The coefficients of Gender (-4.315), Age (1.635), Transaction cost ((-4.727) and Marketing Experience (4.010) of cassava marketer in the Ivo L G A were statistically significant at varied probability levels. More specifically gender and Transaction cost were negative and highly significant at the 1% level of probability. This implies more female in the trade will lead to a corresponding decrease in transaction cost. This conforms with a prior expectation that household activities attached to them and the bulky nature of the trade will lead to a decrease in market efficiency. Transaction cost was negative and significant at 10% level of probability. This implies that any increase in transaction cost will decrease marketing efficiency. This is in agreement with aprior expectation cassava is bulky in enormous nature cost is involved in moving the product from one point to other The coefficient for Age, and marketing experience was positive and significant at 1% and 10% levels of probability respectively. This implies that with an increase in age, the marketing efficiency will increase because the aged ones have been in trade; they know the market techniques and market strategies and perform better than their younger canter parts. Also the more experience the marketer, the better.

Table 1: Social Economic Characteristics of the cassava Marketers

Sex	Frequency	Percentage
Male	14	18.00
Female	66	82.00
Education		
No formal	4	4.34
Primary	17	21.66
Secondary	53	66.0
Tertiary	6	8.00
Age		
24-33	6	7.5
34-43	36	45.00
44-53	26	32.5
54-Above	12	15.00
Household size		
1-4	7	8.75
5-8	36	45.00
9-12	31	38.75
13-16	6	7.5
Marital Status		
Married	57	71.25
Single	12	15.00
Divorced	2	2.5
Widow	9	11.25
Total	**80**	**100**

.Source: Field Survey, 2017

Table 2: Regression Estimates of Determinants of Transaction Costs among cassava Marketers

Variables	**Linear**	**Double log+**	**Semi-log**	**Exponential**
Constant	34.084	4.561**	-1680.078	6.0760***
	(0.324)	(2.729)	(-0.864)	(12.860)
Gender	-30.122	-0.092***	-151.470*	-0.032
	(-1.062)	(-4.315)	(-1.801)	(-0.397)
Educational Level	-0.002	-0.059	-107.158	-1.305
	(-0.614)	(-1.257)	(-572)	-(0.891)
Age	351.442*	0.143*	184.236	0.252**
	(-2.243)	(1.635)	(1.541)	(3.107)
Marital Status	37.252	0.042	-95.818	0.054
	(0.250)	(0.433)	(-0.688)	(0.632
House Hold size	129.353	-0.037	54.937	0.053
	(0.906)	(-0.420)	(0.427)	(0.583)
Transaction Cost(TMC)	-160.676	0.192***	-64.757	-0.208*
	(-0.798)	(-4.727)	(-0.337)	(-1.689)
Marketing Experience	-49.124**	0.486***	470.693*	0.039**
	(-2.961)	(4.010)	(2.329)	(3.129)
R^2	0.527	0.730	0.436	0.343
F.Ratio	3.123	7.532	3.018	6.202

Source: Computed from Field Survey (2017). *, **,*** = significant at 10.0%; 5.0% and 1.0% alpha levels of probability.
Dependent variable = Marketing Efficiency in Naira

Conclusion

This study revealed that the trade is gender sensitive and needs serious strength. The transaction costs and marketing of cassava could be improved by reliable information and government provision of basic infrastructures as this will facilitate faster delivery of cassava and ensure marketing efficiency.

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Socio-Economic Factors Influencing Food Insecurity Coping Strategies of Farming Households under the Sokoto Rima River Basin Development Authority.

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Abstract
Food insecurity is lack of enough and timely access to enough quantity of qualitative food at all times through an acceptable means. This study investigated the factors that influence choices of coping strategies in militating against food inadequacy among irrigation farming households under the Sokoto Rima River Basin Authority. Using a two-stage sampling procedure, 240 households were selected from who information were collected using a well designed questionnaire. The data collected was analyzed using descriptive statistics and OLS. Reducing the quantity of food consumed is the most used coping strategy and 21% and 42% of the households were moderately food insecure and severely food insecure respectively. Farm size and education were found to influence the choice of coping strategies at 5% and 10% level of significance respectively. The study recommends that the households increase their hectrage of irrigation farming cultivation and continue to encourage higher levels of education as these give them a better chance to withstand the effect of food insecurity
Keywords: Socioeconomic, food, Insecurity, Coping and Strategies

Introduction
The term food insecurity refers to lack of access to enough food. According to Lemma and Wondimagegn (2014), food insecurity is the absence of food to everyone at all times which is nutritionally adequate food (in terms of quality, quantity and variety) through a means that is acceptable within the given culture. The majorities of the world's poor and food insecure people live in rural area and they are directly or indirectly dependent on agriculture for their livelihoods. The likelihood of food insecurity is influenced by household level conditions such as education, harvests, health, assets and expenses as well as by regional level conditions such as infrastructure, markets, enabling institutions and conflict or disasters (International Fund for Africa Development, IFAD, 2011). Coping strategies are means by which households survive in the face of food insecurity. Coping strategies according to Snel and Staring (2001) involves a conscious assessment of alternative plans of action. When the quantity of food available to households dwindle, they device means to survive. Previous studies like Olagunju, Oke, Babatunde, and Ajiboye (2012), Abimbola and Kayode, (2013); Ibrahim, H.Y., Adeola, S.S. and Ibrahim, H.I. (2016) have looked at the factors influencing the food insecurity of different household groups however, this study looked into the factors that influences the choice of the food insecurity coping strategies of the households.

Methodology
The North-Western Nigeria is a region comprising of seven states namely: Kano, Jigawa, Katsina, Kaduna, Zamfara, Kabi and Sokoto. There are various irrigation projects across the region. One if the irrigation projects is under the Sokoto Rima River Basin Development Authority. For this study, a Two-stage sampling procedure was used in selecting the households used. In the first stage, four states of the states where the Sokoto Rima River Basins are located were purposively selected (Sokoto, Katsina, Zamfara and Kano). In the second stage, using a random selection based on a

proportionality factor according to Ibrahim (2011), 240 households engaging in irrigation farming were selected for the study. A structured questionnaire was used to collect useful information that was analyzed using descriptive statistics and ordinary least square (OLS) regression. The regression equation is given as: $Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + \cdots + B_{10}X_{10} + \varepsilon$ where B_1-B_{10} are the coefficients of the socio-economic variables in the model; X_1=farm size (ha), X_2=household size (number of dependants), X_3=Years of irrigation farming experience, X_4=distance of farm from home(Km), X_5=distance of home from markets (Km), X_6=dependency ratio, X_7=volume of credit accessed for irrigation farming (₦), X_8=Years of formal education, X_9=Age of household head (Years), X_{10}=number of extension contacts per season of irrigation farming and $\varepsilon = error\ term$. Y=the coping strategy Index Score (whole numbers) generated by the summation of the frequencies of use of each strategy multiply by its severity.

Results and Discussion

Coping strategies adopted by irrigation farming households

In order to survive the challenges of household food insecurity, households adopt various kinds of coping strategies. The irrigation farming households studies in the North-Western Nigeria are not left out. Table 1 below shows the various strategies adopted by the households. The most commonly adopted of the strategies are reducing the quantity of food consumed, eating less preferred meals and consuming seed stocks held for next season as being practiced by 74%, 70% and 67% of the households respectively. Furthermore, the least adopted of the coping strategies include restricting adult consumption, gathering of wild fruits and sending members to eat elsewhere as adopted by 23%, 35% and 35% respectively. It should be noted that because household members adopt more than one strategy at a time, the percentage summation is more than 100% due to multiple responses. A study in Katsina by Ibrahim, Adeola and Ibrahim (2016) revealed that gathering of wild fruits is the most used. The strategy adopted depends on a number of factors chief among is if it is acceptable culturally and not derogatory.

Table 1:Coping strategies adopted by irrigation farming households

Strategies	*Frequencies	*Percentage
Skipping of meals	90	37
Eating less preferred meals	169	70
Begging for food	49	20
Food rationing or reducing number of meals	147	61
Borrowing of food	99	41
Purchase food on credit	133	55
Reducing the quantity of food consumed	178	74
Restrict consumption by adults to enable children eat	56	23
Consume seed stock held for next season	162	67
Send household members to eat elsewhere	84	35
Gather wild food (Fruits)	84	35

*Multiple responses were allowed.

Distribution of households based on their Coping Strategies Index (CSI) Scores

The Table 2 below presents the distributions of the households studied based on their CSI score. The scores of a household also categorized it into a food security status (as shown on the table also). Those with CSI score of between 0 and 2 are considered to be food secured because they use very minimal or none of the coping strategies. The implication of this is that they were food secured and therefore has nothing to cope with. About 22% of the households are in this category. This also means that a good majority of 78% are in various levels of food insecure categories. Majority (42%) of the households are within the Severely Food Insecure categories. They are the households that have CSI score of more than 30. They are the categories that use a higher percentage of the Coping strategies and more frequently per week. The other categories are those with CSI scores of between 3-15 and 16-30. They are the Less food Insecure (15%) and the Moderately Food Secure (21%) categories respectively. These are higher than the findings of Ibrahim, Adeola and Ibrahim (2016). The volume of those within the Food Insecure categories emphasized the relevance of the coping strategies studies and the factors that influence it.

Table 2: Distribution of households based on their Coping Strategies Index (CSI) Scores

CSI scores	Food Security Status	Frequency	Percentage
0	Food Secured	53	22
1-15	Less Food Insecure	36	15
16-30	Moderately Food Insecure	50	21
>30	Severely Food Insecure	101	42
Total		**240**	**100**

Socio-Economic Factors Influencing Food Insecurity Coping Strategies

Table 3 presents the OLS result of the factors influencing the Food Insecurity Coping Strategies among the households studied. The R^2 is 19% implying that the independent variables captured explained 19% of the variation that occurred in the dependent variable. This is possible because there will be many other factors that could not be captured that affects the coping strategies adopted by the households. The F statistics however is significant at 1% level ($p<0.01$) implying that the independent variables captured improved the model. Out of the ten (10) variables captured in the model, about six (6) were significant at various level of significance. The size of farm cultivated by the household was significant at 10% and has a positive sign. This means that it is an important factor in determining how the households cope with food insecurity and that as the size of farm increases, the households have a better ground to cope with food insecurity. Gama, Folorunso and Adeola (2015) established that farm size positively influenced output. This is in line with the *apriori* expectation because; all things being equal, larger size of cultivated farms should translate to more output and better food security level for the households. The distance from home to the farm is significant at 5% level but positive. However, the distance from the market to the homes is negative and significant at 1% level. The negative sign implies that as the distance between the residences of the farmers reduces, they have better ability to cope with food insecurity. This probably might be due to the fact that households buy food on credit (as a coping strategy) and therefore the closer to the source of buying the cheaper(in terms of transportation cost) and more accessible the food becomes (on credit). Furthermore, the result reveals that the level of education of the household heads had a significant impact on the coping strategies adopted. It is significant at 10% and is positively related implying that higher level of education affords better chances of food security coping strategies among the households studied. Similarly, the number of extension contacts the farmers had is significant at 5% and positively related. This is what will be expected as extension trainings will aT ford the farmers of making better choices to handle food insecurity challenges. Although the variable of the amount of credit received per season is significant at 5% it is negatively related with the coping strategies implying that as the volume of credit received increases, the households are likely to have weaker chances to survive. This is contrary to *apriori*expectations. However, this might be possible if the numbers of the farmers that have access to credit are not much.

Table 3. Socio-Economic Factors Influencing Food Insecurity Coping Strategies

R^2 = 0.190438
F statistics = 5.386914

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	13.53907	3.095042	4.374438	1.85E-05
Farm size(Ha)	0.87742	0.464251	1.88997	0.060025
Household Size	0.253163	0.195601	1.294282	0.196872
Farming Experience	-0.04295	0.079297	-0.54163	0.588599
Distance from home(Km)	0.239388	0.10187	2.349946	0.019626
Distance from market (Km)	-0.26531	0.063845	-4.1555	4.59E-05
Dependency Ratio	-1.88567	2.868282	-0.65742	0.511571
Value of credit accessed	-2.4E-05	1.23E-05	-1.9713	0.049894
Level of Education	0.484239	0.278049	1.741564	0.082928
Age of Household head (Years)	-0.02496	0.076826	-0.32488	0.745566
Frequency of Extension Contact	0.402008	0.162775	2.469714	0.014253

Conclusion and Recommendation

From the findings of this study, it is concluded that the irrigation farming households under the Sokoto Rima River Basin Authority are food insecure but uses various coping strategies to survive. The study recommends that the households increase their hectrage of irrigation farming cultivation and continue to encourage higher levels of education as these give them a better chance to withstand the effect of food insecurity

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Analysis of the Utilization of Orange Fleshed Sweetpotato (OFSP) Among Rural Households in Abia State, Nigeria

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Abstract
This study analyzed the utilization of orange fleshed sweet potato (OFSP) among rural households in Abia State, Nigeria .Orange fleshed sweet potato is rich in Vitamin A and serves as a staple food in Nigeria. The study identified the rural household reason for utilization of OFSP in the study area, the factors influencing rural household's level of utilization of OFSP in the study area and identified the rural household constraints in utilization of OFSP in the study area. Data for the study was collected from 72 rural households through a multi-stage sampling techniques using well structured and validated questionnaire. Results on the level of utilization revealed that the rural households frequently utilized orange fleshed sweet potatoes as; food; source of Vitamin A for deficient patients and as fortification of Vitamin A for children. The results of the socio-economic characteristic of rural household influencing the level of utilization of OFSP in the study area showed that the coefficient of age and sex were significant at 5% while the coefficient of household size and level of education were significant at 1%.. Analysis of factors constraining the rural households in utilizing OFSP showed that unavailability of OFSP (37.5%), inadequate income (36.11%) and inadequate information about the nutritive benefits of OFSP (36.11%) were identified by the respondents as constraints faced in their utilization of orange fleshed sweet potatoes in the area. The study recommended that policy makers, extension agents, research institutes and Non-governmental Organizations should create adequate awareness about Orange fleshed sweet potato in rural areas through community- level education programs that will emphasize the needs of vitamin A especially for children and women.
***Keywords**: Utilization, Orange fleshed sweetpotato, rural households.*

Introduction
Orange Fleshed Sweetpotato (OFSP) is a special type of biofortified sweet potato that contains high levels of Beta-Carotene. Beta-Carotene is an organic pigment abundant in plants and fruits and it is converted to Vitamin A in the body after consumption to provide nutritional benefits. OFSP is a staple food in Nigeria and can serve as a cheap and sustainable source of Vitamin A for the vulnerable population (especially children and pregnant women in rural areas) (Maru, 2017). The OFSP was primarily introduced in Nigeria as part of an integrated approach to mitigate Vitamin A deficiency, which affects about 70% of children under age 5, and 11% of women living in rural areas (International Institute of Tropical Agriculture, 2016) and was recently introduced in Abia State in 2016 by National Root Crop Research Institute Umudike. According to Ezeano (2006), the low usage of sweet potato technologies by rural household were attributable to the newness of the crop, its technologies, poor knowledge of the use of the technologies, lack of finance to purchase the inputs and low extension agent-farmer/consumer ratio predominant in the study area. The sweet potato has been utilized in so many ways such as a substitute for wheat in making of flour for bread, cake and other confectionary products (Henok, 2015). It also serves as livestock feed and can be dried to produce chips (Ojeniyi, 2001). Sweet potato can be boiled, fried or roasted and canned. The flour can be used as a substitute for wheat flour in bread making or maize flour in balanced feeds (Rabiu, 2015). Mostly in the rural areas, apart from the roots, the young leaves of

sweet potato serve as green vegetable for man, while the leaves and vines are cherished as fodder and hay by livestock (Olayinka, 2016). In spite of all these benefits of OFSP, rural household socio-economic characteristic that may influence their utilization of OFSP in the study area was relatively unknown. Moreover, the rural household level of awareness on the OFSP is not even known in the area.
While the benefits of OFSP are too many, there exists an on-going debate regarding whether or not households would perceive these benefit and utilize it.The specific objectives were to; identified the socio-economic characteristic of rural households in the study areas; described the rural household reason for utilization of OFSP in the study area; determine the factors influencing rural household's level of utilization of OFSP in the study area and identified the rural household constraints in utilization of OFSP in the study area.

Methodology

The study was carried-out in Abia State, Nigeria. Abia State is in the southeast zone of Nigeria. The study used multi-stage sampling technique in the selection of the respondents for the study. Three agricultural zones of the state were covered in the study. Two local government Areas (LGAs) were randomly selected from each of the zones of the state. Two rural autonomous communities were purposively selected from each of the selected LGAs. This made up to twelve communities. Finally, the list of households in the communities which formed the sample frame was obtained from the community leaders and from the list; six households were randomly selected from each of the communities making it a total sample frame of 72 respondents.

Results and Discussion

Analysis of the utilization of orange fleshed sweet potato (OFSP) among rural households in Abia State, Nigeria. The study revealed that about 44.44% of the respondents identified their reasons for utilization of OFSP as the richness of the Vitamin A content. Results on the level of utilization revealed that the rural households frequently utilized orange fleshed sweet potatoes as; food; source of Vitamin A for deficient patients and as fortification of Vitamin A for children. The results of the socio-economic characteristic of rural household influencing the level of utilization of OFSP in the study area showed that the coefficient of age and sex were significant at 5% while the coefficient of household size and level of education were significant at 1%.. Analysis of factors constraining the rural households in utilizing OFSP showed that unavailability of OFSP (37.5%), inadequate income (36.11%) and inadequate information about the nutritive benefits of OFSP (36.11%) were identified by the respondents as constraints faced in their utilization of orange fleshed sweet potatoes in the area. Table 1 show the results of analysis of the perceived factors influencing rural household's level of utilization of orange fleshed sweet potatoes in the study area.

Table 1: Distribution of respondents on reason for utilizing OFSP

Reason for utilization	Frequency*	Percentage
Cheap to purchase	9	12.50
Easy to cook	25	34.72
It is rich in β-carotene which is a source of vitamin A	32	44.44
For planting	22	30.56
Available throughout the year	11	15.28
Livestock feed	9	12.50
Fresh and healthy to consume	23	31.94
Sweet taste	17	23.61
Quenching hunger	15	20.83
Storage potential	11	15.28
For baby weaning food	16	22.22
Reduces arthritis	8	11.11
Source of energy	20	27.78
Diabetes control	8	11.11
Use as a discard crop	20	20.83

Source: Field survey, 2018.
*Multiple responses recorded

Table 2: Result of Ordinary Least Square Regression analysis of relationship between level of utilization of OFSP and factors influencing utilization of OFSP.

Variable	Linear	Semi-log	Double log+	Exponential
Constant	1.130	-89.663	-1.191	1.473
	(0.186)	(-1.748)	(0.683)	(2.574)**
Age	0.137	6.455	0.668	0.014
	(2.463)**	(2.443)**	(2.686)**	(2.707)**
Sex	-1.462	-1.646	-0.158	-0.138
	(-2.247)**	(-2.549)**	(-2.595)**	(-2.260)**
Marital Status	-0.996	0.968	0.097	0.101
	(-1.170)	(1.140)	(1.216)	(1.260)
Household size	1.022	4.227	0.408	0.100
	(4.566)***	(4.113)***	(4.218)***	(4.743)***
Level of Education	0.428	11.907	1.233	0.044
	(2.898)**	(3.647)***	(4.013)***	(3.166)***
Monthly Income	$9.380e^{-05}$	4.809	0.277	$5.921\ e^{-06}$
	(1.116)	(1.018)	(0.623)	(0.749)
Access to	0.737	0.651	0.051	0.058
Healthcare	(0.937)	(0.811)	(0.674)	(0.780)
Membership of	0.720	0.819	0.074	0.070
Association	(0.924)	(1.048)	(1.010)	(0.951)
R^2	0.452	0.453	0.468	0.467
F ratio	6.491***	6.522***	6.925***	6.891***

Figures in the first row are regression coefficients
Figures in parentheses are t-ratios
t-ratios *** Significant at 1% level; **Significant at 5% level
Source: Field Survey, 2018.

Conclusion and Recommendations

The utilization of Orange Fleshed Sweet Potato (OFSP) among rural households in Abia State, Nigeria, Reviled that rural households were aware of Orange fleshed sweet potatoes and utilized it for various reasons, especially as a source of Vitamin A fortification in food. The National Root Crop Research Institute at Umudike (NRCRI) bulletin was a good source of information about Orange fleshed sweet potato. The study recommends that Extension agents should educate rural households on the nutritive benefits of Orange fleshed sweet potatoes and the various ways it can be utilized and also encourage farmers to utilize the orange fleshed sweet potato technology and increase their production to ensure all year round availability

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Socioeconomic Factors Influencing Production of Cocoyam among Farmers in Ikwuano Local Government, Abia State, Nigeria

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Abstract
This study focused on the socio economic determinants of cocoyam production among farmers in ikwuano local government area Abia state. Data for the study were collected from 90 cocoyam farmers with the means of well structured questionnaire from the six communities in Ikwuano LGA. Data were analyzed by means of descriptive statistics such as frequency distribution tables, percentages and means. Ordinary least square regression analysis was used to analysis the determinants of cocoyam production. The results showed that Cocoyam farmers in the area had mean age of 54 years of which majority (70%) were males, with an average of 30 years of farming experience. The result of the regression analysis showed that five out of the eight explainable variables were significance these include gender, household size, farming experience and land ownership status of the farmers. Sex of the household head significantly and negatively affected output of cocoyam at 5%. Based on the result it is recommended that policies aimed at encouraging the women to go into cocoyam production becomes .
Keywords; Socio economic, Factors, Influencing, Cocoyam, Production, Farmers

Introduction
In Nigeria, the importance of cocoyam cannot be over emphasized, based on the vital role it plays in human nutrition, income generation and source of employment especially among the rural dwellers One of the major constraints is the low fertility status of most of the soil causing the crop to winter due to organic matter and nutrient status of the soil. According to Asumade and Tetteh (2013), cocoyam like any other root and tuber crops is a heavy feeder exploiting greater volume of soil for nutrients and water. There is a need to encourage rural farmers in the cultivation of cocoyam in order to meet the demand for cocoyam and for increase food production. The cultivation of cocoyam is declining. there is need to increase its production because cocoyam is going extinct in most farm lands and markets and can only be seen in few cultivated lands (Okorji and Eze, 2003).Farmers need to be encouraged to continue/promote cocoyam production and making them available in Nigeria market. Most farmers hold on to traditional farming methods of depending on household manure instead of using fertilizer due to unavailable credit facilities and these effects grossly the output of cocoyam. The following constraints have been reported by researchers on Cocoyam production among farmers. Lack of government support, Ineffective extension service, Low demand for the crop, Lack of ready market. , Diseases and pest in the field, Low soil facilities. Labour shortage, Scarcity of organic manure, Rot and decay during storage. Cocoyam is almost going extinct in our farms and markets and there is need for its sustainable production, it becomes pertinent to investigate the socio-economic factors affecting cocoyam farmers in Ikwuano Local Government. This study will serve as a basis for information to the farmers on cocoyam profitability which is expected to drive increased cultivation of the crop

Objectives of the study
i. describe the socio economic characteristics of the respondents;
ii. determine the factors influencing cocoyam production output

Methodology

Multistage random sampling technique was used in selecting the respondents. Two communities were randomly selected from each of the six communities in Ikwuano Local Government Area. With the assistance of key informants, the list and location of cocoyam farmers in each of communities were compiled from which the sample for the study was drawn. Fifteen (15) farmers were sampled from each of the six communities across the State totaling 90 cocoyam farmers in all. Structured questioner was used for data collection. This focus mainly on socio-economic characteristics of the farmers, output of cocoyam in tons, cropping system and constraints militating against cocoyam farmers in the study area. The data for the study were collected in June 2015. The data collected were analyzed using descriptive statistics, Ordinary Least Squares regression analysis

The following is the implicit of the model:

$Y = (x_1, x_2, x_3, x_4 \ldots\ldots\ldots x_n)$ where y = output of cocoyam (in tons).

X_1 = Age of the farmers (in years).

X_2 = sex (gender) of the household head (male = 1, female = 0).

X_3 = household size (in number).

X_4 = years of education of the household head (in years).

X_5 = farm size (in hectares).

X_6 = farming experience of the household head (in years).

X_7 = land ownership status (owned = 1, otherwise = 0).

X_8 = membership of cooperative (1 = yes, 0 = No).

e = Random error term.

Result and Discussion

Majority (62%) of the respondents were aged between 41 -60 years, about 11% fell within 20-40 years; while 27% of the respondents were above 60 years of age , majority (69%) of the farmers were female while 31% were males. This is not an indication that men were less involved in cocoyam production. About 30% of the respondents had no formal education while majority (41%) had Primary education. Majority of the respondents (60%) had household sizes ranging from 6-10 persons; about 32% of the had between 1-5 persons while 8% fell within the size of 11-15 persons. 30% of the respondents had between 10-20 years, while 29% had between 21-30 years of farming experience. 24% of the farmers have 31-4 years farming experience,

Table 2 presents the results of the regression analysis and its shows that the linear functional form had the best fit, based on the values of R2 (0.93), level of significance of explanatory variables and their signs. The f-value of (131.646) indicated that the overall equation was significant at ($p<0.01$) while Durbin-Watson (DW) of 1.996, showed the absence of autocorrelation. Out of the eight explanatory variables specified, five were statistically significant; these were sex, household size, farm size, years of farming experience, and land ownership status of the farmers. Sex of the household head significantly and negatively affected output of cocoyam at ($p<0.01$).

Conclusion and Recommendation

In Nigeria, the importance of cocoyam is indispensible, based on the vital role it plays in human nutrition, income generation and as source of employment especially among the rural farmers. Sex of the household head significantly and negatively affected output of cocoyam at ($p<0.05$)

Recommendations

1.The result therefore calls for policies aimed at provision of free education especially to the girl child and encourage those who are experience to study the production and increase adoption of cocoyam technologies.

2. There is therefore need for government policies towards encouraging the female farmers who are younger more active and agile to increase Production. .

Table 1. Distribution of Socio-Economics Characteristics of the Respondents.

Variable	Frequency	Percent
Age (Years)		
20-30	1	1.1
31-40	9	10.0
41-50	30	33.3
51-60	26	28.9
61 and above	24	26.7
Gender		
Female	62	68.9
Male	28	31.1
Education (Years)		
No formal education	27	30.0
Primary School Education	37	41.1
Secondary School Education	21	23.3
Tertiary Education	5	5.6
Household Size (Years)		
1-5	29	32.2
6-10	54	60.0
11-15	7	7.8
Farming Experience (Years)		
10-20 years	27	30.0
21-30 years	26	28.9
31-40 years	22	24.4
41-50 years	11	12.2
51 and above	4	44
Total	**90**	**100**

Source: Field Survey 2015

Table 2: Result of the Multiple Determinants of Cocoyam Output Regression Analysis for Socio-Economic

Coefficient/Variables	Linear {a}	Semi-Log	Double-Log
Intercept	-0.895	-3.930	-0.367
	(0.845)	(6.137)	(0.377)
Age	0.002	0.734	0.033
	(0.011)	(0.714)	(0.101)
Sex	-0.525	-0.127	-0.010
	(0.188)***	(0.030)***	(0.004)**
Household size	0.317	1.748	0.269
	(0.061)***	(0.534)***	(0.076)***
Education	0.022	0.010	0.002
	(0.024)	(0.024)	(0.003)
Farm size	4.251	1.538	0.235
	(0.594)***	(0.287)***	(0.041)***
Experience	0.048	0.851	0.296
	(0.014)***	(0.445)*	(0.063)***
Land Ownership	0.685	0.111	0.023
	(0.242)***	(0.037)***	(0.0005)***
R_2	0.929	0.861	0.924
Adjusted R_2	0.922	0.847	0.924
F-value	131.646	62.776	122.598
Durbin Watson	1.996	1.919	2.065
Observation	**90**	**90**	**90**

Source: Field Survey 2015

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Assessment of Certified Cassava Seed Flow among Farmers In North Central Nigeria

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Abstract

Nigeria was initiated to bring about commercialization of cassava cuttings and link buyers to producers of certified cassava seeds in the area. The study was conducted using interview schedule, focused group discussion, Phone interviews The development of cassava seed certification and flow through cluster formation among farmers in North central and interaction among cassava seed entrepreneurs and other farmer groups and individuals identified as cassava seed out growers. Two Hundred Respondents were identified and selected through their participation in farmer groups; attendance and participation in Training organized for commercial cassava stem producers and recruited Village seed entrepreneurs (VSEs). Results showed that thirty demonstration plots were established to popularize seed certification among sixteen communities in Benue State. 12000 bundles of certified seeds were sold to five different locations two hundred farmers were trained in ten locations. The results revealed that the Major constraints farmers encountered were uncertainty of market as indicated by 80% of the respondents., improved varieties were sourced largely from fellow farmers while foundation seed was sourced principally from National Root Crops Research Institute (NRCRI) and International Institute for Tropical agriculture (IITA) and development partners such as Catholic Relieve Services (CRS), and also members of cooperatives or ADP contact farmers.

Keywords: Assessment, and Certified Cassava Seed

Introduction

Cassava seed Certification is a recent development in cassava production in the evolving cassava seed system which is hitherto largely informal in Nigeria. Cassava farmers are known to source their planting materials by recycling from their previous fields and also depend on informal cassava cuttings exchange with their neighbors for cassava production with little or no commercial value attached. Consideration was never given to genetic purity and maintenance of standard to prevent mixture of varieties. According to Erker and Brick(2018) Seed certification maintains a pedigree on seed of a specific variety, once a superior variety of seed is developed, painstaking effort must be taken to keep it pure and produce it in large quantities for use. Seeds are basic and critical input for enhancing agricultural production and productivity. The seeds which seeds companies sell in the market and our farmers grow are commonly "certified seeds". The certification of seeds is a legally sanctioned system for quality control of seeds that are used to cultivate crops. The certified seeds are grown under stringent production requirements and they have improved traits such as better yield, pest resistance, drought tolerance, and herbicide tolerance. Agrinfo (2015).The benefits of using quality foundation seeds includes: Genetic purity (true to type). The good quality seed has high return per unit area as the genetic potentiality of the crop can be fully exploited. Seeds are basic and critical input for enhancing agricultural production and productivity. The certified seeds are outcome of few years of research and development to get these improved traits. This R&D is done on their parent plants. On this basis, there are five different categories viz. Nucleus Seeds, Breeder Seeds, Foundation Seeds, Registered Seeds and finally certified seeds. The foundation seed shall be the progeny of the breeder seed, or it can be produced from foundation seed clearly traceable to the breeder seed. Foundation seed is seed so designated by an agriculture experiment station. Its production must be carefully supervised or approved by representatives of an agricultural experiment station. It is the source of all other certified seed classes, either directly or through registered seeds. Breeder seed is used for the production of foundation seed. Foundation seed can be multiplied to meet demands, but should be clearly traced from the breeder seed. Field observations should be made during the entire growing season to monitor the crop under field conditions. Rouging operation should be done carefully from vegetative to maturity stages to remove all possible mixtures. Foundation seed must be certified by a Seed Certification Agency (NSC).

Recent innovation in the seed system has brought about the development of the large scale commercial seed sharing arrangement leading to farmer cluster formation and the emergence of cassava out growers.

The seeds from off springs with best and desired quality are selected and certified as Breeder seeds. Such seeds are protected by legal rights called as Breeder's rights. The Breeder seed is further multiplied into the foundation and certified seeds.

Methodology

The study was conducted using interview schedule, focused group discussion, Phone interviews and interaction among cassava seed entrepreneurs and other farmer groups and individuals identified as cassava seed out growers. Two Hundred Respondents were identified and selected through their participation in farmer groups, registration as large scale cassava producers, attendance and participation in Training organized forcommercial cassava stem producers and recruited Village seed entrepreneurs (VSEs).

Results and Discussion

Results in Table 1 showed that thirty demonstration plots were established to popularize seed certification among sixteen communities in Benue State. 12000 bundles of certified seeds was sold to five different locations two hundred farmers were trained in ten locations. Fig.1 showed certified seed distribution from Benue to various states with the peak of 15000 Bundles circulating in Benue State.

Fig 2 revealed that the Major constraints farmers encountered was uncertainty of market as indicated by 80% of the respondents. This is followed by low knowledge of certification guidelines and scarcity of foundation seeds indicated by 75 and 70% the respondents respectively. Fig. 3 showed that improved varieties are sourced largely from fellow farmers while foundation seed was sourced principally from NRCRI and IITA.

Table 1. Distribution of Respondents According to Activities Carried out By Farmer Groups

Activities	Number	Location
Demo plots	30	16
Cassava cuttings supplied	12000	5
Number of farmers trained	200	10
Number of clusters formed	20	10

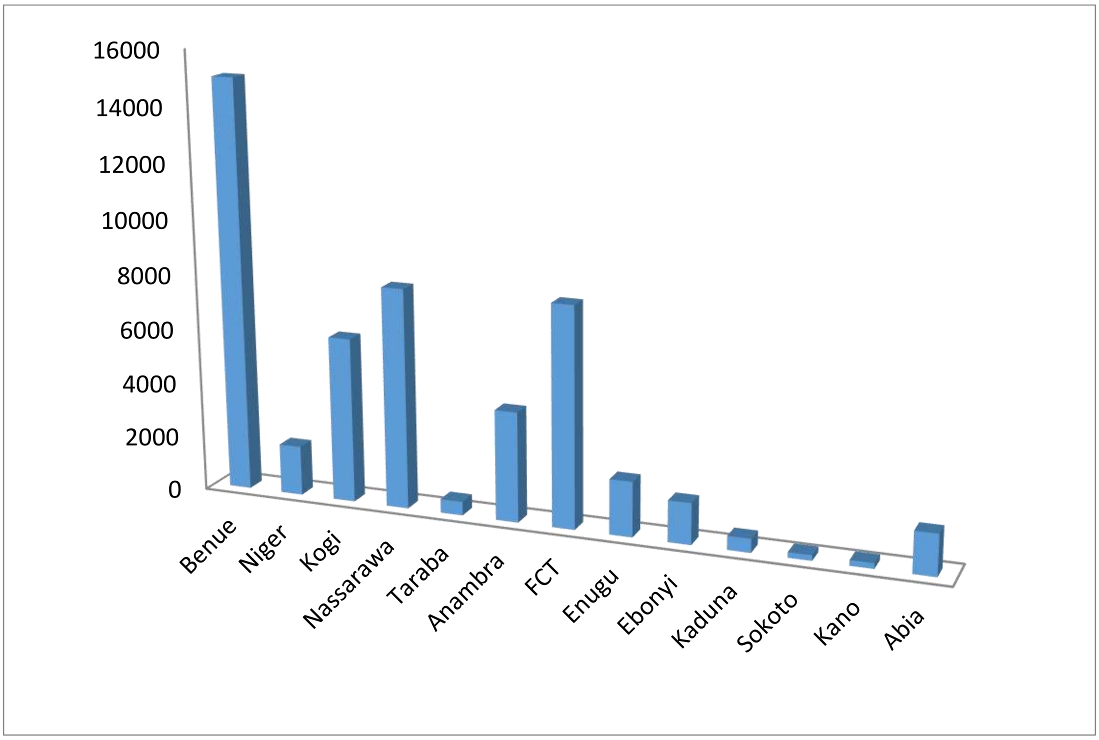

Fig..1 Distribution of sales of certified cassava seeds according to location

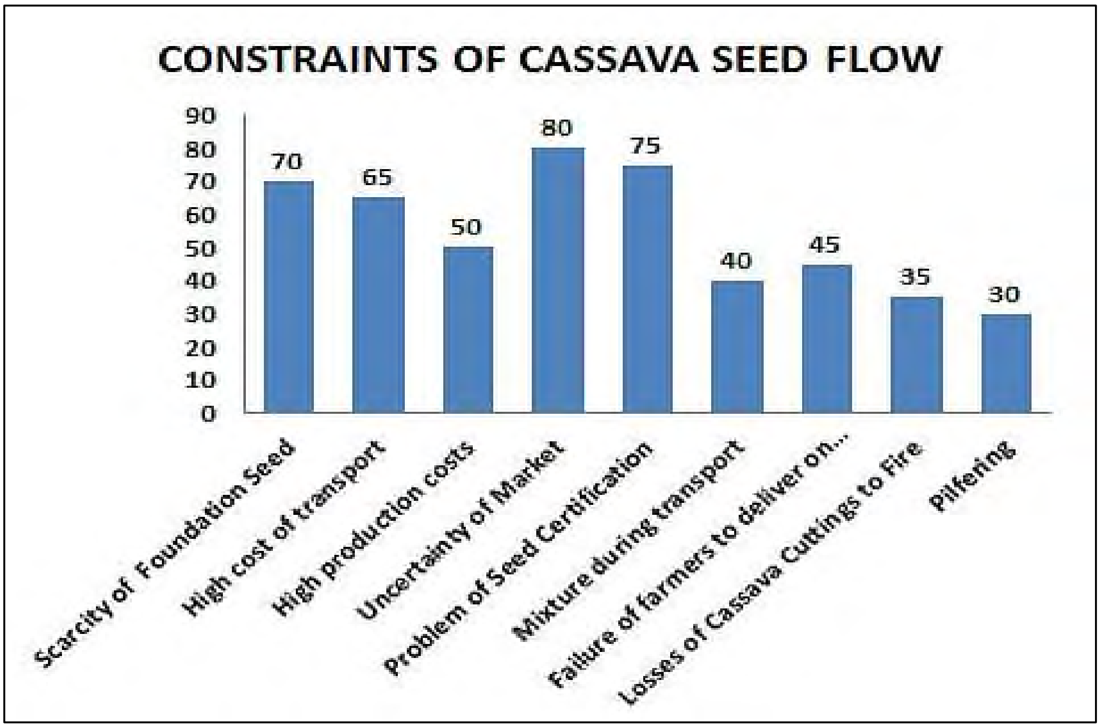

Fig. 2 Distribution of respondents according to constraints experienced in the production of certified cassava seeds

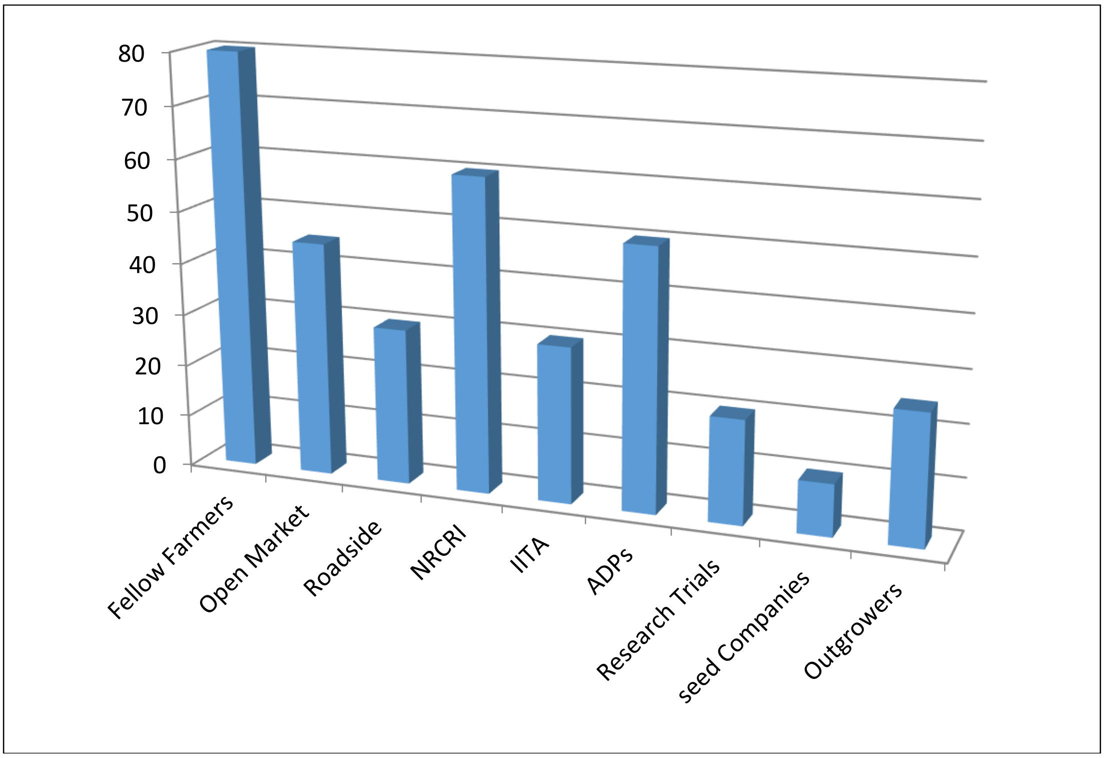

Fig. 3: Sources of improved varieties among the respondents

Transport of Certified cassava Cuttings flow in states in Nigeria

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Profitability Status of Cassava Entrepreneurs in Abia State

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Abstract

The study examined the profitability status of cassava farmers in Abia state. A multistage sampling technique was used to elicit information from 120 respondents with the help of well-structured questionnaire on socioeconomic characteristics and other relevant variables for the study. Both descriptive and net income analysis were used to analyse the data. Results showed that majority of the respondents were between the 41-50 years and greater percent were females(64%), most of the respondents(81%) have formal education, with 7 years and above farming experience . having a family size of 4-9 (80%) people and operating on a farm holding of less than 3 ha. Gross margin result indicated that farmers obtained a net return of 145,604.07 per ha with a benefit cost ratio of 1.35kobo. It was therefore recommended that male farmers most especially the younger ones be encouraged by creating more enabling environment in other to embrace farming as business
***Key words**: socio economic, profitability and cassava*

Introduction

Cassava (*ManihotEsculentuz*Crantz) is an important root crop in Nigeria. Nigeria is the largest producer of cassava in the world. Currently, production of cassava is put at about 34 metric tons. Cassava serves as food for man as well as in feeding livestock animals. Man consumes over two thirds of the total production of cassava roots in various forms and the remainder is used as animal feed. The starchy, thickened storage roots are valuable source of inexpensive calories (Awoyinka, 2009). Cassava roots are consumed raw, boiled or processed into cassava flour which is used in many industries. Leaves are used as vegetable and can be harvested periodically throughout the growing season (Nwaiwu et al, 2010). As a result of its use as an industrial crop, cassava has been categorized as a cash crop. Cassava as an important crop with huge potential and has gained the attention through the launching of "Presidential Initiative on Cassava Production in Nigeria" which was inaugurated with the aim of achieving on annual basis five billion dollars from export of cassava. In spite of the various uses cassava is known for, as an agent of self-sufficiency in food production, the gain derived from its production by rural farmers is still not sufficient to keep the resource poor farmers above poverty line. The socio economic characteristics and resources of individual households have been identified as basic factors influencing the food security status of households (Sanusi et al).When the returns from agricultural production is not be equated to the investment, agricultural production will be left in the hands of the elderly or the non-educated ones who cannot make decision. Efforts aimed at increasing cassava output to meet the demand for the output to meet the demand for output cannot be properly directed unless the costs and returns of cassava production are determined. For cassava production to attain its potential in area of ensuring food security, is important that the socio economic conditions of cassava producers must be known and their profitability be examined. It is to this end that this paper aims at examining the socio economic characteristics and their profitability status of cassava farmers in Abia state, Nigeria. The specific objectives of the study were to; examine the socio economic characteristics of cassava farmers in the study area; determine their profitability status of farmers in the study area.

Methodology

Study area

The study was carried out in Abia state, Nigeria. Abia State is located in the South East geopolitical zone of Nigeria. It has three senatorial zones namely: Abia North, Abia South and Abia Central with seventeen local Government Areas. The climate of the state is tropical one, having rainy and dry seasons. Farming and trading are major occupations of the people.

Sampling technique

The Study adopted multi-stage sampling technique in selecting respondent. The first stage involved the purposive selection of six (6) local government areas from seventeen local government areas of the state. Secondly, four (4) communities will be randomly selected from each of the selected local Government area, five (5) cassava farmers will be randomly selected from each the selected communities, given us a total of 120 respondents.

Analytical techniques Objective (i) which is to examine the socio-economic characteristics of the respondents in the study areas was analyzed with descriptive statistic such as frequencies, means and percentages; objective (ii) which is to estimate the cost-return ratio of cassava farmers in the study area was analysed using Net income analysis.

Specifications of model

For objective (ii) which is estimate the cost-return ratio of cassava farmers in the study area was be analysed with Net income analysis. This is stated as;

NI = TR – TC

Where;

NI = Net income

TR = Total returns

TC = Total cost

Results and Discussion

The socio economic characteristics of the respondents in table 1 showed that majority of the respondent (25.83) were between the ages of 41-50 years. About 20.83% of the respondents were between 31-40 years. This shows that majority of farmers were still active. Age is said to be a primary latent characteristic of adoption decisions.(Bonabona-Walhi, 2002; Nwaru, 2004; Nwawusi et al., 2007 and Agwu and Anyaeche 2007) found out that the ability of a farmer to bear risk, be innovative decreases with age.

Table 1: Socio-Economic Characteristics of cassava farmers.

Age	Frequency	Percentage
<21	3	2.50
21-30	8	6.67
31-40	25	20.83
41-50	25	20.83
51-60	31	25.83
>60	28	23.33
Gender		
Male	56	46.67
Female	64	53.33
Educational attainment		
No schooling	29	22.50
Primary	41	34.17
Secondary	41	24.17
Tertiary	11	9.17
Occupational status		
Full time farming	72	60.00
Part time farming	48	40.00
Membership of cooperative		
Member	28	23.33
Non-member	92	76.67
Household size		
1-3	26	21.67
4-6	46	38.33
7-9	37	30.83
>9	11	9.16
Farming experience		
1-10	21	17.50
11-20	63	52.50
21-30	25	20.83
>30	11	9.17
Farm size		
<1	20	16.6
1-1.9	43	35.83
2.0-2.9	57	47.50

Source: field survey 2016

The results show that 53.33% and 46.67% of the farmers were females and males respectively. This implies that women constitute a greater percentage of those involved in cassava cultivation in the state. This indicates that cassava production is not gender exclusive but is mostly carried out by the female folk.Findings from the study also showed that 22.50% of the respondent did not attain any form of formal schooling while most (34.17%) attained primary and secondary levels each. Educated farmers are expected to be more receptive to improved farming techniques. While farmers with low level of education or without education would be less receptive to improved farming techniques (Okoye et al., 2004 and Ajibefun and Aderinla, 2004).The results further showed that majority of the farmers were into full time farming while 40.00% were part time farmers. Full time farmers are expected to treat farming as business by applying improved farming practices and informed management decisions on their farms. The results show that majority (76.67%) of the farmers do not belong to any cooperative societies while 23.33% were members. Farmers who belong to cooperative societies are expected to access more fertilizer because of the present fertilizer policy where farmers are encouraged to form cooperative to enhance easy access to fertilizer. The result from table 1 showed that 38.33% and 30.83% had household size range of 4-6 and 7-9 persons. This shows that the study area is dominated by respondents with large households, Effiong (2005) and Idiong (2005) reported that a relatively large household size enhance the availability of labour. About 52.50% of the farmers had farming experience between 11-20 years while 9.17% had more than 30 years of farming experience. This implies that the farmers have long years of farming experience.About 35.83 % of the respondent had farm size of 1-1.9ha while majority (47.50%) of the farmers operate on farm holdings of about 2-3ha. This shows that they are smallholder farmers. Farm size affects adoption costs, risk perceptions, human capital, credit constraints, labour requirements, tenure arrangements and more. With small farms, it has been argued that large fixed costs become a constraint to technology adoption (Abara and Sing, 1993) especially if the technology is costly.

Cost and Returns Analysis of Cassava Production per hectare in the Study Area

The results in Table 2 showed the profitability analysis of cassava production in the study area. The results showed a total revenue of N567635.07 (N420,635.07 from cassava roots and147,000.00 from sale of stems).

The total variable costs generated was N419,451.00 and total fixed cost of N2, 490.00 A gross margin and profit estimates of N148,184.00 and N145,604.07 respectively were generated.

Table 2: Cost and returns analyses of cassava production in Abia State per hectare

Item	Qty	Price	Total
A-Revenue			
Roots	17,295.95	24.32	420,635.07
Stem	420	350	147,000.00
Total			**567,635.07**
B-variable costs			
Fertilizer	125	150	18,750.00
Herbicide	3.00	1,800	5,400.00
Cassava stems	98	350	34,300.00
Total			**58,450.00**
Land clearing	23.48	1,500.00	12,975.00
Land preparation	36.50	1,500.00	54,750.00
Stem preparation	4.71	1,400.00	6,594.00
Planting	8.65	1,500.00	35,220.00
Weeding	82.17	1,500.00	123,255.00
Herbicide application	2.60	1,200.00	3,120.00
Fertilizer application	13.67	1,500.00	20,505.00
Harvesting	63.55	1,500.00	95,325.00
Transportation			9,257.00
Total			**361,001.00**
Total variable cost			**419,451.00**
C-fixed costs			
Hoe	6	400.00	2,400.00
Machete	5	1800.00	9,000.00
Knife	4	250.00	1,000.00
Basin	5	500.00	2,500.00
Spade	4	2,500.00	10,000.00
Total			24,900.00
Depreciated (10 years) total fixed costs			2,490.00
Total costs (B+C)			422,031.00
Gross margin (A-B)			148,184.00
Profit (A-B-C)			145,604.07
BCR = Revenue/TC			1.35:1.00

Source: Field survey, 2016

Conclusion and Recommendation

From the findings of the study, it was observed that majority of the farmers are active and young, that greater percent where female .It was therefore recommended that male farmers most especially the younger ones be encouraged by creating more enabling environment in other to embrace farming as business.The profitability analysis proofed that cassava farming is a profitable venture in the study area. It recorded a gross margin of 148,184.00 per ha. The benefit cost ratio shows that for every one naira invested in the enterprise, a profit of 1.35kobo will be realised.

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Analysis of Trends in Accessed Loans and Repayments under Agricultural Credit Guarantee Scheme in Cross River State, Nigerian

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Abstract
The study analyzed trends in farmers' accessed and repayment of Agricultural Guarantee Scheme Loan (ACGS) in Cross River State, Nigeria from 1977 to 2017. Time series data obtained from the Central Bank of Nigeria were analyzed using descriptive and regression techniques. The empirical results showed that accessed and repayments of ACGS loans were influenced both in short and long runs. Exponential growth rates of 2.60% and 14.96% were obtained for loan accessed and repaid respectively. The quadratic trend analysis showed that accessed of ACGS loans were increasing at a decelerating rate over a long period of time; while repayment became stagnated over a long period of time. The policy implication is that financial institutions became reluctant to participate in ACGS Fund in the State. This affected the level of adoption of agricultural innovation that drove modern farming practices. With the creation of the Commercial Agricultural Credit Scheme in the State in 2010, farmers moved to the State's loan window (whose financial was small,) to acquire credits for their productions thus abandoning defaulted loans to increase in value. It is recommended that efforts be geared toward narrowing the big gap between accessed loans and repayment which will encourage more banks to participate in the Scheme.
Keywords: Accessed, Repayment and Agricultural guarantee scheme loan

Introduction
The demand for food is increasing due to growing world population. It is a known fact that a strong and efficient agriculture sector has the potential not only to feed its population, create employment, and generate foreign exchange but also provide primary raw materials for industries. These have multiplier effects on all sectors of the economy. Globally, there has been increase demand to expand farm production in the last two decades than ever before 1980s. The main cause seemed to be associated with increased growth rate in population with alarming unemployment rates. In realization of the above situations, many polices, programmes, schemes/ projects and institutions have been established in many of the developing economies for the purpose of extending loans to farmers. In Nigeria for instance, the Government has established specialized schemes/funds and banks to channel loans to the agricultural sector of the economy. It is the realization of the core role which agricultural credit plays in agricultural economy and agribusinesses that large amount of funds have been committed to farmers and agro-entrepreneurs in the country through formal public credit schemes/institutions. These schemes are usually promoted by Government but financed and driven by the private sector. In facilitating increased availability of credits for agricultural production and encourage the banking system in extending loans and advances for agricultural purposes, the Federal Government of Nigeria widely adopted various strategies to remedy the challenges of financing agriculture through the establishment of specialized public credit institutions such as Nigerian Agricultural Cooperative and Rural Development Bank which later became Bank of Agriculture and the Agricultural Credit Guarantee Scheme Fund later (CBN, 2010). The Federal Government of Nigeria legally established the Agricultural Credit Guarantee Scheme Fund (ACGSF) in March 1977 with the Central Bank of Nigeria (CBN) as its Managing agent. According to the provisions of the ACGSF Act, the Fund commenced operation with an authorized capital of one hundred million naira, shared between

the Federal Government and CBN in the ratio of 60 to 40 percent. The authorized share capital subscription continued to increase over the years from an initial contribution of N85.50 million as at December, 1977 to N357.70 million as at 1998 and N4 billion as at 2006 (Umoren, 2008). The purpose of the Scheme/Fund is to encourage deposit money banks to lend to farmers for agricultural production by providing guarantee for loans granted by such banks for the purpose as enunciated in the ACGSF Act of 1977. Umoren, (2008) maintained that the cardinal purpose of ACGSF was to guarantee loans/advances to the banking sub-sector and minimize credit/lending risk. In recent time, not much effort has been focused on the analysis of trends in Accessed loans and repayment under Agricultural Credit Guarantee Scheme at the State level. Cross River State for instance is an agrarian State that has benefitted from the scheme for a long period of time. The study sought to provide answer to such question as 'what are the trends in ACGS loans/advances and repayments from 1978 to 2017 in Cross River State? Premised on above issue, the specifically analyzed the trend in accessed ACGS loans and repayments in Cross River State over a certain period of time space. The results from the study would provide a spring board for policy formulation by the regulator, participating financial institutions, farmers and other stakeholders in the agrarian economy.

Materials and Methods

Study Area, Data Source and Analytical Technique

The study was conducted in Cross River State, located in the southern region ofNigeria. It occupies land area of 20,150km (National Population Commission, 2006). Secondary data used in the study were collected from the statistical bulletins of the Central Bank of Nigeria (CBN). The study employed trend analysisand simple regression model to analyze data collected. The study period spanned from 1978 to 2017.

The trend Analysis of ACGS Loans Accessed and Repayment's Performance in Cross River State, Nigeria (1978 – 2017)

The study investigated the nature of exponential growth rate in accessed ACGS loans over time in Cross River State, Nigeria. An exponential trend equation was specified as thus:

$$log_e ACSLAD_t = b_0 + b_1 T + U_t \ldots\ldots\ldots\ldots (1)$$

Where:

'T' is the time e[illegible]d in year; $ACSLAD_t$ is the value of ACGS Loans accessed in Cross River State. $ACSRE_t$ represents ACGS loan repayments over time

$$log_e ACSRE_t = b_0 + b_1 T + U_t \ldots\ldots\ldots\ldots (2)$$

The exponential growth rate in ACGS loans ($ACSLAD_t$) is given as: (r) =$(e^{b1} - 1) * 100 \ldots\ldots\ldots (3)$

The trend equation and the exponential growth rate were estimated for Accessed ACGS loans and Repayment in Cross River State ($ACGRE_t$).T = Time expressed in year (i.e. 1, 2… 40) b_0 =intercept and U_t = error term.

The Quadratic trend equation

$$log_e ACSLAD_t = b_0 + b_1 T + b_2 T^2 + U_t \ldots\ldots\ldots\ldots (\mathbf{4})$$

This was inserted to test the impact of increase time on ACSRE and ACSLAD

ifb_2>0; then variable under investigation indicates accelerated growth rate whereas $b_2 < 0$ it indicates that variable under investigation has decelerated growth rate over time while b_2= 0 shows stagnation (Edet, Akpan and Patrick, 2014)

Results and Discussion

Table 1 shows the descriptive summary statistics for ACGS accessed loans and repayments during the study period. The mean values for accessed loan/advances guaranteed and repaid in Cross River State are N2418230 and N29428570 respectively. Furthermore, the maximum and minimum accessed and repaid N2,9579,000.00 and N246,000.00 respectively whereas maximum and minimum repaid loans were N137,190,000.00 and N288,800.00 respectively.

Table 1:Descriptive Summary of ACGS Accessed and Repaid Loan in Cross River State (1976-2017)

Descriptive statistics	ACSLAD	ACGLRE
Mean	24184.23	29428.37
Median	1560.900	4592.100
Maximum	295795.0	137190.0
Minimum	246.0000	288.8000
Std. Dev.	64611.17	38294.11
Skewness	3.358180	1.154666
Kurtosis	13.47577	3.155176
Observations	40	40

Source: Authors' computations 2018.

These statistics showed wide disparity between Accessed loans and repayment under ACGS in the study area. These might suggest poor behavioural capacity of beneficiaries in favour ofaccessed ACGS loan and repayment. It could also suggest poor farmers – banks relationship issues

Exponential linear trend equations for ACSLAD and ACGLRE

Tables 2 presents the results of estimated linear trend equations for ACGSaccessed and repaid loans in Cross River State during the study period. The result revealed that, both loan accessed and repaid varied directly with time. In other words, these variables increase as time increases. The exponential growth rates stood at 2.6% and 14.9% for loan accessed and repaid respectively. This means that, loan disbursement rate was far lower than the repayment rate. This could likely be attributed to the high rate of default among beneficiaries in the State. The structure and the working mechanism of the ACGS could also be responsible for this conspicuous difference in the growth rates of the ACGS accessed loan and repayment during the study period.

Quadratic trend equations for ACSLAD and ACGLRE

The result for the quadratic trend equation for ACGS loan accessed and repayment is shown in Table 3. The coefficient of time squared for loan access is significant and is negatively signed. This implies that, accessed ACGS loans in Cross River State were increasing at a decelerating growth rate over a long period of time. In other words, the volume of loan disbursed by ACGS in the State did not sufficiently or efficiently match the demand within the period of study. On the other hand, the coefficient of time Squared in ACGS repayment equation was positive and insignificant. This implied that, loan repayment over a long period of time was stagnated in the State and perhaps it impedes accessibility.

Table 2: Exponential linear trend equations for ACSLAD and ACGLRE

Variable	Exponential linear trend equation in ACSLAD	Exponential linear trend equation in ACGLRE
	Coefficient(t-test)	**Coefficient(t-test)**
Constant	7.378(11.98)***	5.884(25.20)***
Time	0.026(0.996)	0.149(15.08)***
Exponential growth rate (%)	**2.60**	**14.96**
R-squared	0.025419	0.856846
F(1, 38)	0.991109	227.4477***

Source: Computed by Authors using EView. Asterisks ***;** and * represent 1%, 5% and 10% significance levels respectively. Variables are as defined previously.

Table 3: Quadratic trend equations for ACSLAD and ACGLRE

Variable	Quadratic trend equation in ACSLAD	Quadratic trend equation in ACGLRE
	Coefficient (t-test)	**Coefficient (t-test)**
Constant	4.977(6.09)***	6.137(16.93)***
Time	0.369(4.015)***	0.114(2.79)***
Time squared	**−0.008(-3.848)*** **	**0.001(0.91)**
R-squared	0.303959	0.859998
F(1, 38)	8.078896	113.6406***

Source: Computed by Authors using EView. Asterisks ***;** and * represent 1%, 5% and 10% significance levels respectively. Variables are as defined previously.

Therefore, dynamic Agricultural loan scheme/ programs as well as institutions must change over time to facilitate increased participation by the lending institutions and beneficiaries in Cross River State.

Figure 1 showed the pictorial trends in Agricultural Credit Guarantee Scheme accessed loans and repayment in Cross River State during the period of the study. The graph depicted a wide disparity between Accessed loans and repayment. This trend might have discouraged the participating financial institutions from granting more loans to farmers which would have greatly accelerated agricultural production in Cross River State from 2000-2006. The peak periods for ACGS loans accessed and repayments occurred around 2009 to 2010. This might have been associated with impact of interest drawback, a rebate package aimed at reducing effects high market driven interest rate on ACGS loan beneficiaries in the country. This might suggests that incentive-linked credit facility could improve loan repayments. This pushed more beneficiaries and operators to increase accessing loans and lending to the farmers respectively

Conclusion and Recommendations

The major findings from the study showed that accessed and repayments of ACGS loans exhibited accelerated trends within the year while over a long period of time the trend in accessed loan decelerated whereas repayments remains stagnated. There is a wide gap between value of accessed loan and loan repayment over time in Cross River State which might have suggested bylow participation among lending institutions and the beneficiaries over the years. Thus the awareness, strategies and guidelines of ACGSF might be too slow in catching up with the current development in financial market approaches in reaching out to farmers in Cross River State. These could be ascribed to high cost of lending and poor business environment coupled with poor incentives and awareness of the Scheme in Cross River Stare. It is suggested that incentive-linked credit facility could improve loan repayments. This could push more beneficiaries and operators to increase access loans and lending to the farmers and institutions respectively. Furthermore, it is also recommended that feasible incentives that would encourage inclusive –sustainable growth and participation be institutionalized by the Managing Agent of the Scheme.

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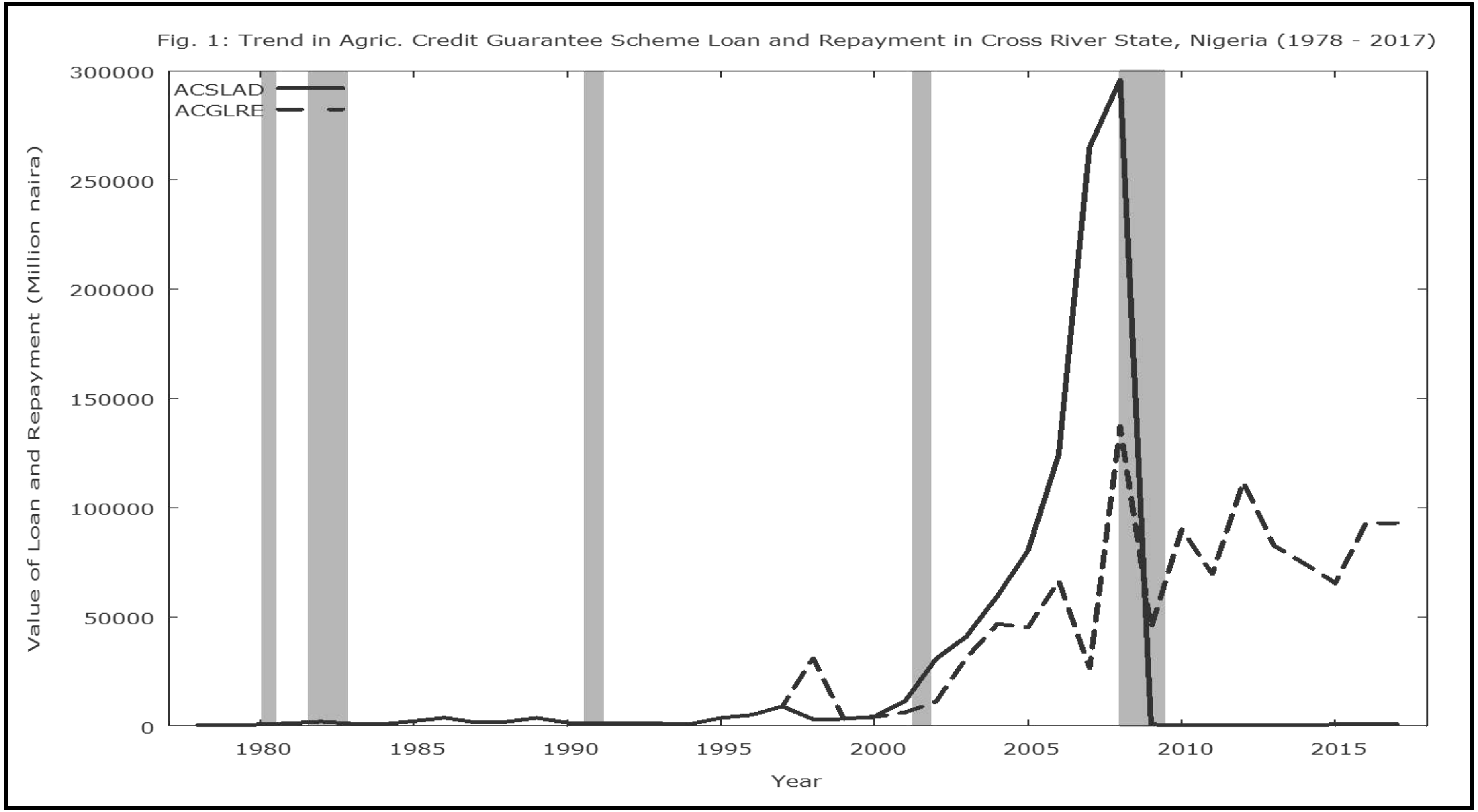
Figure 1: Graph of Accessed ACGS Loans and Repayment in Cross River State (1978-2017)



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A Review of Economic Importance and Efficiency of Cocoyam Production in Nigeria

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Abstract
Cocoyam ranks third in importance and extent of production after yam and cassava in Nigeria. This can be expanded by emphasizing the need to market the crops in such a way as to maximize returns. Nigeria is the world's leading producers of cocoyam, accounting for up to 3.7 million metric tonnes annually. Given that cocoyam is an important staple food in Nigeria, any attempt to increase its productivity would be a right step towards the resolution of food crisis. The implication of the review is that efficiency in cocoyam production among the farmers could be increased through better use of available resources given the current state of technology.

Keywords: Cocoyam, Economics, Importance, Production and Nigeria.

Introduction
Agriculture has been an important sector in the Nigerian economy in the past decades and is still a major sector despite the oil boom. Basically, it provides employment opportunities for the teeming population, eradicates poverty and contributes to the growth of the economy. Despite these however, the sector is still characterized by low yields, low level of inputs and limited areas under cultivation (Izuchukwu, 2011). Root and tuber crops which are among the most important groups of staple foods in many tropical African countries constitutesthe largest source of calories for the Nigeria population . Cassava (*Manihotesculenta*) is the most important of these crops in terms of total production, followed by yam (*Dioscoreaspp*), cocoyam (*Colocasiaspp and Xanthosomaspp*) and sweet potato (*Ipomoea batatas*). Cocoyam (*Colocasiaesculenta*and *Xanthosomamafafa*) are important carbohydrate staple foods particularly in the southern and middle belt areas of Nigeria (Asumugha and Mbanaso, 2002). Nutritionally, cocoyam is superior to cassava and yam in the possession of higher protein, mineral and vitamin contents in addition to having more digestible starch. Cocoyam which ranks third in importance and extent of production after yam and cassava is of major economic value in Nigeria. Edible cocoyam cultivated in the country is essentially species of *Colocasiaspp* and *Xanthosomaspp*. The average production figure for Nigeria was 5,068,000mt which accounts for about 37% of total world output of cocoyam (Food and Agricultural Organization, 2011). Small scale farmers, especially women who operate within the subsistence economy grow most of the cocoyam in Nigeria. The surplus of the product is supplied to the market in the rapidly growing urban centres. The bulk of the production of cocoyam is in Southern Nigeria. According to them a large number of households grow cocoyam as a cash crop, selling at least half of their yearly production. As a food crop cocoyam tubers are eaten in homes in various forms. They can be boiled or roasted like yam. They can also be pounded or mixed with cassava and eaten with soup. Research on cocoyam has trailed behind that of other staples in Nigeria and other countries. Ezedinma (1987), Had earlier noted that the totality of published scientific work on cocoyam is insignificant when compared with those of rice, maize, yam and cassava. That was only in the last decade that policy makers and national agricultural research systems began to show systematic interest as a result of a number of technical, socio-economic and institutional constraints, which need to be addressed. This review is expected to provide valuable information on profitability and production efficiency of growing cocoyam to enable farmers consider its production as a viable option.

Cocoyam Production in Nigeria

Cocoyam production is available all the year round, making it preferable to yam, cassava, etc. It is more resistant to drought, pests and diseases and tolerance to a variety of climatic and soil conditions on the farm. It is one of the recognized crops in Nigeria. Apart from the tuber, other parts of the cocoyam plant are of domestic significance. For instance, the leaves and petioles may be cooked and eaten as a vegetable, taro *spp*is a valuable staple carbohydrate food, relatively easy and inexpensive to produce. It has become a staple food for most Nigerians, not only among rural people but also among the urban dwellers. Furthermore, its roots are storable in the ground for months after they mature. Where cocoyam production system aim to produce human food, animal feed or industrial raw materials, yield is not the only objective. A further qualification of the earlier simple objective is that money is often the ultimate product which is required from the system through the sale of the crop materials. Profit from the system and an adequate return on investment are important consideration. Efficiency in the use of financial resources in growing crops is an important factor. This can be expanded by emphasizing the need to market the crops in such a way as to maximize returns. As noted by Zubair and Hunter (2000), the cultivation of cocoyam is not encouraging as the yield per hectare is still low. One of the reasons for the low yield may not be unconnected to dismal and little attention farmers give to cocoyam when compared with cassava and yam that are close substitute root/tuber crops. For profit efficiency of cocoyam farmers to be increased, there is need for the qualitative extension services among farmers. Their performance and interest in this respect have to be rose. Cocoyam farmers can be helped to obtain high yield through introduction of modern and effective farm technologies and improved varieties by the extension services, which bring about expected result to the farmer.

Cocoyam Producing Countries

Cocoyam ranks third in importance after cassava and yam among the root and tuber crops cultivated and consumed in Nigeria (Udealor *et al*., 1996). Currently, Nigeria is the world's leading producer of cocoyam, accounting for up to 3.7 million metric tonnes annually (NRCRI, 2003). This accounted for about 40 percent of total world output of cocoyam (Eze and Okorji, 2003).

Table 1: Top ten cocoyam producing countries in the world

Rank	**Countries**	**Production(mt)**
1	Nigeria	32,657,440
2	China	1,702,367
3	Cameroun	1,490,000
4	Ghana	1,299,650
5	Madagascar	224,888
6	Papua New Guinea	222,916
7	Japan	171,928
8	Rwanda	168,521
9	Central Africa	122,719
10	Republic Philippine	110,718

Source: FAO (2011)

Conclusion

This review shows that cocoyam production in Nigeria is profitable .Given that cocoyam is an important staple food in Nigeria; any attempt to increase its productivity would be a right step towards the resolution of food crisis. This can be achieved through improved farmer-specific factors. These review call for policies aimed at encouraging new entrants especially the youths who are agile and stronger to grow cocoyam and the experienced ones to remain in farming.

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Cost and Returns Analysis of Small-Scale Dry Season Tomato Production in Onitsha Agricultural Zone, Anambra State

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Abstract
The study analyzed the cost and returns of dry season tomato production by small scale farmers in Onitsha Agricultural Zone of Anambra State, Nigeria. Eighty farmers were randomly selected for the study and data were analyzed, using descriptive analysis and profitability analysis. The results showed that the mean age of the farmers was 41 years, implying that they were in their active ages. The respondents were fairly educated as about 40 percent of them had secondary school education. The result of the profitability analysis revealed average gross margin and net income per hectare of N105,414.05 and N86,710.57 respectively. This indicated that dry season tomato production was a profitable venture in the study area. The analysis further identified inadequate farm credit, poor storage and processing facilities and inadequate extension services as the main problems faced by the farmers. The study therefore recommends that farmers should be encouraged to form cooperative societies so as to enable them obtain loans from commercial banks and agricultural banks at regulated interest rates. Government should provide efficient extension services in the study area by organizing workshop, training and make provisions to facilitate their work and provide adequate storage facilities.
Keywords : Cost, Dr season Tomato

Introduction
Tomato (Lycopersiconesculentum Mill.) is one of the most cultivated vegetable in most regions of the world, ranking second in importance in many countries (Ojo*et al.,* 2009). In Nigeria, an annual total area of one million hectares is reportedly used for its cultivation and it makes up about 18 percent of the average daily consumption of vegetables in Nigerian homes (Chidi, 2012). Nigeria is also ranked second largest producer of tomato in Africa and thirtieth largest in the world, producing 1.701 million tonnes of tomato annually at an average of 25-30 tonnes per hectare (FAO, 2010).Nwalieji *et al.* (2015) opined that both wet and dry season tomato cropping systems, contributes immensely to the national requirement; though bulk production is from the dry season cropping. The broad objective of the study therefore, was to analyze the cost and returns of dry season tomato production by small-scale farmers in Onitsha Agricultural Zone of Anambra State, Nigeria. In Nigeria, there are two distinct seasons, the rainy and dry seasons. The rainy season is the normal cropping season and starts from April and stops in October, while the dry season starts from November and ends in March. During the rainy season, the production of tomato is high; resulting in saturation of the market, but during the dry season, there is usually the scarcity of this important farm product, thereby leading to a high price due to short supply. This seasonality has resulted in food insecurity, which is a challenge to sustainable food production. There is therefore need to encourage dry season tomato cropping system so as to bridge the demand and supply gap. Dry season tomato production in Anambra State is done mainly in swampy (Fadama) areas along river banks. This activity is both an income earner as well as a source of employment to a large proportion of the populace or otherwise, underemployed labour force (Nwalieji *et al.,* 2015)
Tomato is perhaps the most important popular vegetable crop grown all over the country. Tomatoes are important in the daily meal preparation since it can be eaten raw or cooked. Larger quantities are used to produce soups, juice and sauces, ketchups, purees and paste. It can be used

in canning industries; green tomatoes are used for prickles and preserve. The seeds which are extracted from the pulp and its residues contain 24% oil, which is used for salad dressing and in the manufacturing of margarine and soap. The residual press cake is used as stock feed as well as fertilizer. In addition, vegetable such as tomato, apart from being consumed at home, also earns foreign exchange to the producer countries, due to exportation. Quite a number of studies have investigated the cost and returns of small-scale dry season vegetable production (Usman and Bakari, 2013; Ehirim *et al.,* 2014; Onoh *et al.,* 2016; Samshunnahar *et al.,* 2016; Tsoho and Salau, 2012; Ajayi and Nwalieji, 2010; Nwalieji *et al.,* 2015; Sanusi and Ayinde, 2013). The results from most of these studies highlighted the need to extend the farming season beyond the rainy season through irrigated agriculture, since self-sufficiency in food production based on rain-fed agriculture is difficult to achieve (Ajayi and Nwalieji, 2010).

Methodology

Study area

The study area was Anambra State and it has 4 agricultural zones namely Anambra, Awka, Onitsha and Aguata. Onitsha zone was purposively selected for the study because of the high intensity of tomato production in the area and also the proximity to swampy (fadama) areas which support tomato production. A total of 80 farmers were selected, using a multi-stage random sampling technique across the zone.

Methods of analysis

Descriptive statistics were used to analyze the socio-economic characteristics of the respondents as well as problems faced by the respondents, while profitability of tomato farmers was determined by Gross Margin and Net Income Analysis. Afolami and Ayinde (2002) defined gross margin as the difference between the gross farm income (GFI) and the total variable production cost (TVC); while net farm income (NFI) was defined as the difference between gross margin and total fixed production cost. It is expressed as follows:

$$GM = TR - TVC \quad (1)$$

Where:

GM = Gross margin (N/Ha)

TR = Total revenue (N/Ha)

TVC = Total variable costs (N/Ha)

And

$$NFI = GM - TFC \quad (2)$$

The variable costs mentioned include seed, family labour, hired labour, tractor hiring, transportation, fuel, empty basket, fertilizer, and agrochemicals; while fixed costs include: depreciation on fixed assets and rent on land.

Results and discussion

A summary of the socio-economic characteristics of the sampled respondents in the study area reveals that actual mean estimates obtained for variables did not show much variation (Table 1). Most of the farmers were still within the productive age. Majority of the farmers in the area were young and energetic male farmers with reasonable literacy level. The table further revealed that most of the respondents were married and it is likely that they produce tomato, to cater for their family. About 45 percent of the respondents had less than five years of experience in tomato production. This may affect their efficiency, because the more experienced a farmer is, the more efficient he may be on the farm and vice versa. The table further indicated that majority (84 percent) of the respondents were small scaled and command farm holdings of 0.1 – 2.0 hectares. This implied that mechanized farm production among the respondents could not be feasible.

Table 1: Descriptive Statistic of some of the socioeconomic variables

Variable	Mean value	Standard deviation
Proportion		
Age	41	10.13
Education	0.40	0.32
Farm size	0.72	1.42
Extension	1.76	1.91
Farming experience	1.89	3.42

Source: Data analysis, 2013

Average Cost and Returns per Hectare

Table 2 showed the cost and returns analysis of tomato production among the respondents. The average gross revenue per hectare generated by tomato farmers in the study area was N298,240.20 while the total average cost of production incurred during the production was N211,529.63. The average gross margin and net farm income per hectare therefore, were N105,414.05 and N86,710.57 respectively. Hired and family labour, empty basket, loading and transportation, as well as fertilizer accounted for 65.25% of the total variable costs. The farm gross ratio was 0.58; the ratio showed that the total farm cost was about 6% of the gross revenue, which is in line with Olukosi and Erhabor (2008), which states that a gross ratio of less than one is desirable for any farm business. Therefore, based on the information in Table 2, it is obvious that dry season tomato production was a profitable venture in the study area.

Table 2: Average Costs and Returns per hectare

Variables	Value (N)	(%)
Variable cost		
Fertilizer	20,865.12	9.12
Agrochemicals	21,844.54	10.15
Seed	5,545.20	3.56
Family labour	38,724.74	17.02
Hired labour	50,494.52	20.14
Loading & transportation	21.950.60	12.54
Fuel	10,500.93	7.53
Empty baskets	22,900.50	12.16
Total Variable Cost (TVC)	192,826.15	92.22
Fixed cost		
Rent on land	6.453.48	2.58
Depreciation on fixed assets	12,250.60	5.20
Total Fixed Cost (TFC)	18,703.48	7.78
Total cost of production (TVC + TFC)	211,529.63	100
Returns		
Gross revenue (GR)	298,240.20	
Gross margin (GR – TVC)	105,414.05	
Net Farm Income (GM – TFC)	86,710.57	
Farm Gross Ratio (GM/TR)	0.58	

Source: Field survey, 2013

Table 3: Constraints Associated with Tomato Production

Constraints	Frequency	%	Rank
Inadequate farm credit	70	23.75	1
Poor storage and processing facilities	48	21.25	2
Inadequate extension services	45	17.23	3
Attack by pests and diseases	42	13.95	4
Storage/high cost of inputs	38	9.67	5
High cost of fuel	28	07.35	6
Land shortage	25	06.80	7
Total	**300**	**100**	

Source: Field survey, 2013
Multiple responses

The result in Table 3 showed the constraints faced by the respondents. The table revealed that, the major problem faced by dry season tomato producers is inadequate credit facilities, which accounted for 23.75%. This is in line with the study by Usman and Bakari (2013), who reported that, inadequate capital hinders tomato farmers from expanding their business. This was followed by poor storage and processing facilities (21.25%). This problem causes the price of tomatoes to fluctuate with season. Farmers are forced to sell their produce at harvest at a very low price. Inadequate extension services among producers were also a major challenge to most producers (17.23%). Due to this problem, dissemination of new production technologies among the respondents was bound to be limited. Similarly, 13.95% of the respondents pointed out high incidence of pests and diseases as a constraining factor. Another problem mentioned by the farmers was shortage/high costs of inputs which necessitated farmers to use organic manure. This is in line with the report of Afolami (2002), who noted high input cost among tomato farmers in Ogun State. In addition, about 7.35% of the respondents mentioned high cost of fuel while 6.80% mentioned shortage of land, as other problems facing tomato farmers in the study area. All these problems can limit output and profit; they can also explain the prevalent poverty cycle among the respondents.

Conclusion and Recommendations

The results indicated that majority of the tomato farmers in the study area were married and also males in their active ages. The study also showed that most of the respondents were small-scale farmers, with little experience in tomato production. However, the respondents make good farm profit, with average gross margin and net farm income per hectare of N105,414.05 and N86,710.57 respectively. While inadequacy of farm credit was identified as the most significant problem among the respondents, land shortage was the least significant constraint. The study therefore, recommended that farmers should be encouraged to form cooperative societies so as to enable them obtain loans from commercial banks and agricultural and rural cooperative bank, at regulated interest rates. Government should ensure efficient extension services in the study area by organizing workshops, training and make provisions to facilitate their work and also provide adequate storage facilities.

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Emerging Potentials of Pro-Vitamin A Cassava In Nigeria Food Security Situation-A Review

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Abstract
Consumption of the pro vitamin A cassava could be an antidote to fight hidden hunger and food security issues in Nigeria. Bio-fortified [illegible] out of the to eradicate hidden hunger in rural and urban households in Nigeria. The review assessed the emerging potentials of pro-vitamin A cassava consumption in Nigeria and its contribution to the state offood security. Specifically, it explained the concept of pro-Vitamin A Cassava, assessed the nutritional and health benefits of pro vitamin A cassava and identified the constraints to the consumption of pro vitamin A cassava in Nigeria. The awareness and consumption of pro vitamin A cassava in Nigeria is ongoing growth funding support from Harvest Plus, Nigeria and the collaborative efforts of Federal College of Agriculture, Akure, Ondo State.The paper found that pro vitamin A cassava could help to address the adverse health effects of vitamin A deficiency among urban and rural consumers of cassava products because of its high Vitamin A content. Harvest Plus has established the proof of concept that consuming Pro-vitamin A cassava could eradicate hidden hunger and solve some health related issues. Constraints in Pro-vitamin A cassava consumption including accessibility of Pro-vitamin A cassava products in the market, ignorance of the nutritional benefits of Pro-vitamin A products and low level of utilization of Pro-vitamin A cassava products. The study concluded that access to Pro-vitamin A cassava products will eradicate hidden hunger and its complexities among rural and urban households in Nigeria. The study recommended that Harvest plus and all collaborators should create more awareness of the various nutritional and health benefits of Pro-vitamin A cassava among rural and urban households in Nigeria and also make available the stems of Pro Vitamin A cassava to interested farmers
Keywords: Bio-fortified, Vitamin A Deficiency, Cassava

Introduction
Food security "exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". From the statement above, four components of food security are identifiable: availability, accessibility, utilization and stability of food. Food insecurity remains prevalent, particularly in the global southern nations of Asia and Africa, and in Nigeria, malnutrition has resulted in death of many of its citizens. African Food Security Briefs (AFSB) estimated that approximately one out of every three persons in the sub-Saharan Africa is undernourished.(Matemilola and Elegbede,.2017).Cassava also known as *Manihotesculenta*or *Manihotutilissima* is a widely-consumed staple food in Nigeria, it was considered a promising vehicle for bio-fortification to increase vitamin A content and, therefore, dietary intake. Cassava production occurs predominantly in the southern rainforest savannah ecological zones. Relatively small quantities are produced in northern Nigeria, although drought tolerant cassava varieties are being introduced into those areas as well. The initiative to expand the range of cassava production

to drier zones is supported by drought tolerance breeding initiatives at IITA and CIAT.Cassava roots are primarily white in colour and contain no pro-vitamin A. Vitamin A deficiency continues to be a significant public health problem in Nigeria, despite improving diets due to rising incomes and administration of vitamin A capsule and fortification programs over the past decade. The first variety of pro-vitamin A cassava was approved for release in Nigeria in late 2011, eight years after crop development activities were initiated in 2003 at the International Centre for Tropical Agriculture (CIAT) and the International Institute of Tropical Agriculture (IITA) under funding from the Harvest Plus program. Five years after release and thirteen years after initial research activities, it is estimated that one million Nigerian farm households are growing "yellow" cassava varieties, which contain significant amounts of pro-vitamin A even after processing. Yellow cassava now represents an additional source of vitamin A in Nigerian diets which is essential for eyesight. Products derived from pro-vitamin A cassava include garri, starch, tapioca, fufu, pellets, flour and chips. It is produced mostly by smallholder farmers on marginal or sub-marginal lands of the humid and sub-humid tropics (Ani, 2010). Such smallholders systems as well as other aspects of its production often creates problems, including; the unreliability of supply, uneven quality of products, low producer prices and often costly marketing structure.

Pro- Vitamin A Cassava is an extremely adaptable crop, it is drought tolerant, high yielding resistant to major pests and diseases ,requires limited land preparation, and grows well in poor soils.

Objectives of the Study

The objectives of the study are to;

i. explain the concept of pro-vitamin A cassava;
ii. discuss the nutritional and health benefits of pro vitamin A cassava; and
iii. identify the constraints encountered in the cultivation and consumption of pro-vitamin A cassava in Nigeria.

Methodology

The study was carried out to review present trend on the emerging issues of Pro-Vitamin A Cassava in Nigeria Food Security Situation.

Concept of Pro-Vitamin A Cassava

Vitamin A is a fat soluble vitamin playing an important role in vision, bone growth, reproduction and in the maintenance of healthy skin, hair and mucous membrane (FAO/WHO, 2010).The World Health Organization has established the Estimated Average Requirement (EAR) for vitamin A by age group. For children 4-6 years, this is 275 μgretinol; and for women, 500. Adequate vitamin A is important for healthy immune function; vitamin A deficiency leads to severe visual impairment and increased risk of illness and death from common infections. Cassava had been chosen for bio-fortification in Nigeria because of its importance as a staple crop. It is a staple food and animal feed in tropical and sub-tropical Africa, Asia and Latin America. It's a preferred candidate for use as vehicle to convey vitamin A to target beneficiaries- women and children less than 5 years. Other factors such as food preferences, the number of people consuming cassava and cassava-based products, and the population size of those in need of Vitamin A were also considered in the selection of cassava and Nigeria as a pioneer country. There has been remarkable progress since its inception. (Dixon,*et al*.,2010). Bio-fortified vitamin A "yellow" cassava can help address the adverse health effects of vitamin A deficiency because of its high Vitamin A content. HarvestPlus has established the proof of concept that vitamin A cassava varieties can be developed without compromising yield levels and that these varieties are widely accepted. Bio-fortified cassava could alleviate some aspects of food insecurity in developing countries if widely adopted (Montagnac, 2009).

Potentials of Pro-Vitamin A Cassava in Human Diet

Two forms of vitamin A are available in the human diet: preformed vitamin A (retinol) and pro-vitamin A carotenoids. Preformed vitamin A is found in animal-source foods; pro-vitamin A is found in some plant-source foods, and is metabolized by the body into retinol when consumed. Vitamin A cassava has numerous functions; while vitamin A is best known for its vital role in vision, the retinoid forms of this vitamin also participate in physiological activities related to the immune system, inflammatory system, and maintenance of epithelial and muscular tissues, growth, and reproduction among others. (Ilona, *et al*.,2017). Biofortified vitamin A "yellow" cassava can help address the adverse health effects of vitamin A deficiency. In 2016, Harvest Plus and its partners among whom are the Federal College of Agriculture, Akure and International Institute of Tropical Agriculture; Ibadan (IITA) had successfully developed and delivered vitamin A cassava varieties to more than one million farming households in Nigeria. The Federal College of Agriculture has embarked on the awareness and multiplication of Pro-Vitamin A cassava with efforts of the provost, Dr. Adeola Samson Odedina through various programmes in the institution, Ondo State and in Nigeria. In terms of availability ,the country director, Dr. Paul Ilonanoted that pro-vitamin A cassava varieties are being multiplied and at least 50% of households have already received information on the importance of bio-fortification through farmer to farmer, field days (FCA, Akure), and radio jingles (Ilona, *et al*. 2017).These have helped to increase awareness of Pro-Vitamin A products in urban and rural households .The country Director of Harvest Plus further stated that farmers and consumers have also become increasingly nutrition conscious, leading to the rapid integration of bio-fortification in to food and dietary systems. Yellow fufu has become a preference for fufu consumers while yellow garri (biofortified) is a growing preference for consumers in regions that traditionally consume white garri.

Challenges Encountered in Promoting the Consumption of Pro-Vitamin A Cassava in Nigeria
Constraints in pro-vitamin Cassava consumption in Nigeria includes but not limited to;

i. Inadequate information on the health and nutritional benefits of pro-vitamin A cassava products among rural and urban households;
ii. Poor market opportunities for pro-vitamin A cassava products; and
iii. Low level of utilization of pro-vitamin A cassava products among rural and urban households.

Conclusion

The review concludes that access to Pro-vitamin A cassava products will eradicate hidden hunger and its complexities among rural and urban households in Nigeria.

Acknowledgement

The authors acknowledged the funding support from HarvestPlus Nigeria to the Federal College of Agriculture, Akure in the massive awareness and multiplication of Pro-Vitamin A cassava in Ondo State and in Nigeria at large.

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On-farm income generation of snail production among small holder snail farmers in Ikpoba-Okha Local Government Area, Edo State, Nigeria

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Abstract
This study was conducted specifically to ascertain the socio-economic and enterprise characteristics as well as determine the profitability of on-farm income generation among small holder snail farmers in the study area. Primary sources of data were obtained from questionnaire administered to fifty (50) snail farmers in the study area. The result indicated that the farmers were old adults with a mean age of 50 years; a mean household size of thirteen (13), literacy level was high, income level was low and snail production in the study area was profitable. It is recommended that the farmers should diversify production as well as form co-operative society. It is also recommended that extension agents should be encouraged to have contact with the farmers.
Keywords: On- farm, production, small-holder, snail and income

Introduction
A major concern of the Federal Government of Nigeria is how to increase food production and ensure security. Dixon *et al* (2011) reported that hunger and malnutrition are consequences of food insecurity. The only economic sector that can address this perennial problem of food insecurity is agriculture (Kaine 2018). Ume and Kaine (2017) and CBN (2013) reported that the contribution of agriculture to the national gross domestic product (GDP) is about 48%.This is why Adaigbo and Nwadioha (2010) reported that agriculture an important pivot for economic development of most developing countries of the world. Agenor *et al* (2004) reported that agriculture is a vehicular means of reducing poverty. Kaine (2017) reported that the agricultural sector provides the protein requirements for the healthy growth and development of man. However, Adeniyi *et al* (2012) reported that animal protein is regarded as first class or high quality protein due to the presence of high amount of amino acid.Snail farming in recent times is becoming popular such that it is now complementing snails from the wild life (Nwadukwe, 2000). Snail meat is good source of protein; it provides the much needed protein for growth and healthy development of both the rural and urban dwellers. The protein content of snail is about 12 – 16%. It is low in fat (0105 – 0.80%), high in iron content (45.50mg / kg) and contains the essential amino acid required by man (Ugwumba *et al,* (2016). Snail meat is useful in the treatment of ulcers, asthma and anemia due to the high iron content (Efamspro, 2008). Several studies have been conducted in different areas of snail production, however, little or no study have been conducted with respect to on-farm income generation of snail production among small holder snail farmers in IkpobaOkha Local Government Areas of Edo State, Nigeria. This research therefore was carried out to determine the socio-economic variables enterprise characteristics and profitability of snail production in the study area.

Methodology
On farm income generation of snail production among smaller holder snail farmers was conducted in IkpobaOkha Local Government Area, Edo State, Nigeria.. A total of fifty identified snail farmer were randomly selected and used for the study. First stage involved the selection of communities. Five communities were randomly selected. The second stage involved selection of snail farmers.

Ten snail farmers were randomly selected from each of the five communities using well-structured questionnaire giving a total sample size of fifty that was used in the study. Data for the study was generated using primary data. Data generated were coded and analyzed using both quantitative and qualitative techniques.

Model specification

Profitability Analysis

Profitability analysis of snail production among small-holder snail farmers was determined using the gross margin analysis. Gross margin analysis (GM) is expressed as the difference between total revenue (TR) and total variable cost (TVC). Net profit margin (NPM) shows the difference between gross margin and depreciation. Gross Margin and Net Profit is expressed as

Gross Margin and net profit is expressed as:

GM = TR – TVC

TC = VC – TFC

NPM = GM – Depreciation

Where

GM = Gross Margin

TR = Total Revenue (#)

VC = Variable Cost (#)

NPM = Net Profit Margin

Return on Investment (ROI)

This was obtained by dividing the net profit by total cost of production multiplied by 100 and expressed as a ratio (Kaine, 2018). The equation is expressed as:

$$\mathrm{ROI} = \frac{NetProfit\ (Revenue)\ perannum}{TotalCostincurredperannum}\, x\, \frac{100}{1}$$

Result and Discussion

The socio-economic variables of dry snail farmers were presented in Table 1. The result showed a mean age of fifty (50) years. This indicated that the farmers were old youths involved snail production. The result also showed that snail gender specific both sex were involved in the production. Further analysis showed that thirty nine (78%) of the respondents were married. The result further revealed that literacy level among the farmers was high as only three (6%) of the farmers had no former education. A mean household size of thirteen (13) was observed in this study.

Table 1: Socio-economic characteristics of Respondents (n=50)

Variables	Frequency	Percentage	Mean
Age			
Less than	35	06	12
36 – 45	09	18	
44 – 55	24	48	
56 – 65	07	14	
Above 65	04	08	50.32
Gender			
Male	38	76	
Female	12	24	
Marital Status			
Single	06	12	
Married 39 78			
Divorced/ Separated	02	04	
Widow/Widower	03	06	
Educational attainment			
No formal education	03	06	
Primary education	16	32	
Secondary education	26	52	
Tertiary education	05	10	
Household Size			
Less than 05	15	30	
06 – 10	19	38	
11 – 1 5	10	20	
16 – 20	06	12	13

Source: Field Survey, 2018

Farmer's enterprise statistics as represented in Table 2 showed that the farmers were well experienced with a mean experience of ten (10) years. The study also showed that small holder snail farmer majorly (64%) financed their enterprise through personal savings. A detailed analysis of the status of the farmers showed that thirty nine (78%) of the respondents were part time snail farmers. Farm size analysis showed that the farmer small holder farmers a mean production capacity of one thousand, eight hundred and eighty one (1,881) snails. The study also showed that the farmers were low income earners with a mean income of #206,360.00. Forty eight (96%) of the farmers had no contact with extension agents. The result also showed that forty three (86%) were not members of cooperative society and were all involved in other on-farm activities.

Table 2: Enterprise statistics of farmers in the study area (n=50)

Variables	Frequency	Percentage	Mean
Fish farming	02	04	
Cash crop farming	12	24	
Small stock farming	02	04	
Poultry farming	06	12	
FME			
01 – 05	04	08	
06 – 10	24	48	
11 – 15	16	32	
16 – 20	06	12	10
Sources of finance			
Personal saving	32	64	
Loan	12	24	
AFFR	06	12	
Status of farmer			
Full time	11	22	
Part time	39	78	
Income level (Naira)			
Below 100,000	02	04	
101, 000 –200,000	25	50	
201,000 – 300,000	18	36	
Above 300,000-206,360 -	05	10	
Farm size (Number of snails)			
Less than 500	03	06	
500 – 1000	04	08	
1001 – 2000	12	24	
2001 – 3000	28	56	
Above 3000	03	06	1880.84
Membership of organization			
Yes	07	14	
No	43	86	
Contact with extension agents			
Yes	02	04	
No	48	96	

Source: Field Survey, 2018.* FME: Farming/Marketing Experience *AFFR : Assistance from friends and relatives
* OFA:On farm activities

The profitability of snail production among small holder farmers in the study area was determined and presented in Table 3. The result indicated that the total variable cost was one hundred and sixty four thousand, five hundred and seventy naira thirty four kobo (#164,574.34) while the total fixed cost was one hundred and sixty three thousand and twenty naira, thirty two kobo (#163020.32). The result showed that snail production was profitable in the study area with a return on investment of 0.23. This implies that for every one naira invested there is a return of 0.23 naira.

Table 3: Profitability of snail production among small holder snail farmers

Average Depreciated Cost	318,316.67
A Variable Cost (VC)	
Baby slug/Baby snails	68,576.80
Feeds	11,338.65
Labour	12,776.89
Water	73,682.00
Insecticides	8,200.00
Total Variable Cost	**164,574.34**
B Fixed Cost	
Production house	
47,650.49	
Production constructed structures	95,620.30
Wire gauze / wire mesh	5,027.73
Cutlass / knives	2,360.34
Metal drums	2,396.10
Harvesting basins	3,450.00
Incubating buckets	2,190.66
Feeders / feeding trays	1,786.00
Watering troughs	620.00
Watering sprayers	568.70
Interest on loan	1,350.00
Total Fixed Cost	**163,020.32**
C Total Cost (TC): TVC + TFC + Depreciation	**645,911.33**
D Total output: (3687)	
Sales per snail: 300	
Total Sales: 3687 x 300	1,106,100.00
E Net Profit Margin (NPM): Gross Margin (GM) – Depreciation	**787,783.33**
F Profit	
Sales – TC (787,783.33 - 645911.33)	141,872.00
Return on Investment	**0.23**

Source: Field Survey, 2018

Conclusion

The result of the study revealed that on-farm snail farmers were old youths with high literacy level and house-hold size. The result also revealed that on-farm snail production was profitable. Further analysis established that farmers were low income earners and majority had no access to extension agents. The result also showed that majority were not in any form of cooperative. Since the study established that the farmers were low income earners, it is recommended that they should diversify into off-farm enterprise. It is also recommended that the farmers should form co-operative society so as to achieve the benefit of economies of scale. Since majority of the farmers had no contact with extension agents, it recommended that extension should be encouraged to have contact with the farmers.

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Village Seed Entrepreneur Model: Prospects and challenges for a Sustainable Cassava Seed System in Southeast Nigeria

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Abstract

Building a Sustainable and Integrated Cassava Seed System is a project that seeks to develop a formal cassava seed system in Nigeria. One key strategy to achieving this is the village seed entrepreneur model as drivers of change in the rural farming communities. The village cassava seed entrepreneurs are already existing cassava farmers in selected communities who, having adopted the use of improved cassava varieties, have the capacity and are willing to take up cassava seed production and marketing as a business. High yielding and disease free (clean) planting materials (Certified cassava seed) from the foundation seed are multiplied and sold to cassava farmers who are expected to increase the yield of cassava in Nigeria. In this business model, the village seed entrepreneurs are expected to produce at least 400 bundles of cassava seed per hectare with the root as extra source of income. With the potential of multiplying specific improved varieties of cassava to plant 8 times the initial farm size means a huge yield increase and better income to farmers. However, aside bulkiness of cassava seed and difficulty in moving it from one location to another, the complexity of seed sourcing behavior of cassava farmers in southeast Nigeria are some of the numerous challenges faced by the village seed entrepreneurs. Also, slow diffusion of the adopted improved cassava varieties is likely to slow down market opportunities for certified seed selling in the rural communities. Cassava farmers tend to hold on to the already existing varieties in their area due to perceived desirable traits for different food forms. It is therefore suggested that a more aggressive sensitization programmes such as the use of radio jingles and market day promos be intensified to popularize the village seed entrepreneurs in the communities and possibly enlarge the number of existing participants.

Key words: Cassava, seed, certified, production, market, improved, varieties, sustainable, integrated, entrepreneurs, system

Introduction

Since its emergence in Africa in the 16th and 17th centuries, cassava has replaced several traditional staples and has been successfully incorporated into many farming and food systems on the continent. This crop, initially adopted as a popular famine reserve crop because it provided a more reliable source of food during drought and hunger periods, has in recent times emerged to be both a staple food and profitable cash crop of industrial significance in the world economy (Aerni, 2006).The production of cassava is dominated by over 6 million families, typically smallholders with an average farm size of 0.5 Hectares. Over 90% of these farmers use the informal seed system by recycling stems from the previous harvest. Less than 5% buy new stem cuttings, leading to poor yields. Cassava production is plagued with issues of inefficient production and distribution of quality planting materials and an unreliable quality assurance system. These issues hinder the production of quality cassava roots that are of interest to end users particularly industrial processors (Sahel Capital 2016).Nigeria is currently the largest cassava producer in the world with estimated annual production of over 50 million metric tons.Despite being the largest cassava producer in the world, Nigeria only averages a yield of 14 t/ha–less than half of what is attainable, due largely to the use of low yielding varieties that are most time not clean. It is acknowledged in some quarters that the seed industry in Nigeria is still developing especially for crops like cassava whose botanical seeds are not consumed or popularly used for planting. However, seeds are the

foundation of agriculture and the most important input (Onunka*et al* 2016) in the production process of most crops especially root and tuber crops. Although cassava planting materials can be produced from true seeds, or rapid multiplication method, the crop is propagated by stem cuttings and the main sources of the planting materials are the farmers' fields, farmers' neighbours and sometimes rural markets. High-quality cassava cuttings for planting are often in short supply.Thus the introduction of improved varieties and agronomic practices into cassava production system consequently can increase yields per unit area by 40% (Nweke *et al.* 2001). A survey conducted in Nigeria in 2003 indicated that a lack of clean planting material (clean stakes) was by far the most important problem in cassava production systems, followed by low yields of fresh roots (Dickson, 2003).
Building an economically sustainable, integrated cassava seed system (BASICS) is a project that seek to help Nigerian cassava producers reach the potentials of 45MT/ha by involving the development of a commercially sustainable cassava seed value chain based on the purchase of quality seed by farmers. To further ensure the sustainability of the project, vibrant and profitable village seed entrepreneurs are encouraged to venture into the seed business. These seed businesses will provide healthy seed of more productive varieties leading to adoption of new varieties to improve productivity and food security, increase incomes of cassava growers and seed entrepreneurs, and enhance gender equity. The village seed entrepreneur model is a distinctive pathway of seed delivery in thepilot States of Benue, Abia, Imo, Cross Rivers and Akwa Ibom states, to help develop a network of 130 community based seed enterprises. These VSEs will source certified stems of improved varieties of cassava from NRCRI and IITA to multiply and sell to farmers in their vicinity. This way, farmers will not have to go far to source quality stems for planting. It is expected that the VSE model will increase incomes to the farmers, ensure that women are given opportunity to express their potentials in cassava seed business and facilitate sales of quality seed of new, farmer, and market preferred varieties. The strategy is to carefully select grass root entrepreneurial seed producers in the project target areas as VSEs using laid down criteria to ensure compliance requirements for certification by the National Agricultural Seed Council of Nigeria. Some of the criteria for selection of the VSEs include:

- Ability and willingness to take up seed production as a business
- Must have adopted the use of improved cassava varieties
- Should possess the financial ability to cultivate at least 1ha of cassava field
- Must belong to a registered cooperative society
- Must be ready to be trained
- Must abide by seed certification regulations by NASC

The VSEs are trained on improved agronomic and business management practices of cassava production, so that they can establish and manage their own small seed business. These VSEs are linked to National Agricultural Seed Council (NASC) so all their seed production plots are duly certified so the buying farmers are assured of the quality.Apart from building their capacities, Catholic Relief Services (CRS) and National Root Crops Research Institute (NRCRI) Umudike, in partnership with other institutions support the VSEs by facilitating the availability of certified foundation seed to meet their planting material needs and by creating demand for their produce through strategic communication and marketing campaigns. A number of strategically located demonstration plots are set up to showcase the benefit for using certified seeds for planting. (http://www.rtb.cgiar.org/basics/activities/village-seed-entrepreneurs/).

The National Agricultural Seed Council (NASC) will pay certification visits to the VSEs at least three times before the stems are harvested for sale. These visits are to ensure that the guidelines for seed certification are followed to produce clean certified cassava seed. Also, the VSE is expected to obtain foundation seed every two years from NRCRI seeds, GoSeed and Reniscence (Agro alliedSeed Company) who are foundation seed producers. Breeder seeds are produced by research institutes such as NRCRI and IITA.The success of cassava seed multiplication and marketing depends on the quality of planting material. Quality should actually separate the local and improved varieties. The criteria used in determining quality of planting materials of cassava are generally based on the threshold levels of infestation of diseases and pests. Certified cassava seed implies that the stems are clean and has been authorized for distribution and use in the cassava based farming systems of Nigeria by the Nigeria Agricultural Seed Council (NASC). This paper therefore discusses the prospects and challenges of the VSE model as a pivot where the production and marketing of clean cassava seed will rotatein Southeast of Nigeria.

Prospects for the VSEs in Southeast Nigeria

To ensure availability of foundation seed for the VSEs at all times, National Root Crops Research Institute (Umudike Seeds) and Renascent Agro Inputs and seed company ltdare producing enough to ensure that the backup of new and clean seed are available. Training and retraining is an integral part of the programme designed to equip the VSEs with the required skills that they need to be efficient in the cassava seed multiplicationbusiness. Some key aspects of these trainings include Best Agronomic practices, Development of business models and networking using the cassava seed tracker technology. The seed tracker will enable the VSEs to become visible by prospective buyers in Nigeria and beyond using the internet communication technology to create market.In Africa, about 600 million people are dependent on cassava for food (IFAD 2012). Cassava stem production as a profitable venture requires compromising the root yields by reducing the planting distance to as low as 1m x 0.5m inter and intra row spacing instead of the normal 1m x 1m spacing. By this arrangement, the plant population of about 20,000/ha is expected. This will translate to about 400-500 bundles of cassava stem at first ratoon depending on variety. In the south east of Nigeria, the price of improved cassava stem went a record time high in 2017. A bundle of cassava stem was sold as high as ₦1,000 for TME 419 and ₦1,500 for the pro vitamin A varieties. This means that a VSE can realize up to ₦500,000 from stem on a 1ha farm of improved cassava variety within the first 6-9 months after planting. However, in 2018, the price of stems generally dropped to between ₦500 to ₦800 per bundle, also indicating a positive trend for cassava seed business in the area.Because of the clean cassava stems planted by the VSEs, their farms are usually outstanding in the community, attracting the attention of other farmers who, in turn would want to have such variety of cassava in his/her farm. Community based farmers are likely to cluster around the VSEs for information concerning cassava. Markets are created within the cluster of farmers around a VSE. The multiplier effect of this will mean that within two planting seasons in a locality, the VSE will form a kind of nucleus for certified cassava seed. In some locations in the Southeast of Nigeria, cassava is now planted almost all year round. This will imply increased demand for certified seeds. Huge transaction cost incurred during the movement of cassava stems due largely to its bulky nature is eliminated because of the presence of the VSEs within the farmer's environment. Cassava farmers may no longer travel beyond their community to obtain certified seed for planting.This strategy will positively impact on the incomes of the farmers.

Challenges to the VSEs

High cost of transportation of foundation seed to the location of the VSEs poses a serious challenge to operators in the scheme. Also, the packaging and method used to convey these stems, predisposes the stems to varietal mix up in transit. When this happens, the VSE is not likely to be able to sort out the different varieties and plant them separately in different certification fields as specified by NASC. This could further lead to supply of wrong cassava varieties other than the one requested by their clients. Also, slow diffusion of the adopted improved cassava varieties is likely to slow down market opportunities for certified seed selling in the rural communities. This is because cassava farmers in some communities are yet to see reasons why they should discard the already existing varieties that they have been using over the years, for which they appear, satisfied with their performance in terms of quality.

In Nigeria, the seed industry is still developing especially for crops like cassava whose botanical seeds are not consumed or popularly used for planting. Although production of cassava is dominated by over 6 million families, typically smallholders with an average farm size of 0.5ha, over 90% of these farmers use the informal seed system by recycling stems from the previous harvest (Sahel Capital 2016). The common characteristics of the existing informal seed system include:

- Cassava seed gets to farmers from fellow farmers
- Bought from local markets
- Sourced from friends and well wishers.

- Collect cassava stems from farms where harvesting has been carried out and the stems abandoned in the field.
- Cassava farmers see stems as not useful except as planting material.
- Cassava varieties are distributed in such a manner that the farmer may not trace the source of his planting materials

Typical of Nigerian farmers, a vast majority of the rural farming population especially cassava farmers still hold on to the above practices. In some localities, sharing of cassava seed among friends and relatives is a common practice. This has made it somehow difficult for VSEs to sell the certified seeds as planned. In extreme cases, these certified seeds are harvested from the VSEs farm without the consent of the owner. The sharing of cassava seed ideology that is prevalent in most rural communities of southeast Nigeria is most likely to frustrate some of the VSEs out of business. It is reported that in AkwaIbom State for instance, people go about harvesting TME 419 variety of cassava stem without the consent of the owner, due to the popularization of the variety by a programme that is supported in the state by the wife of the governor (personal communication with a VSE). Again, the business model aspect of the project has not been fully embraced by the VSEs. Some are still dragging their foot to invest their money to purchase foundation seed from NRCRI or Reniscence. They are yet fully comply with NASC regulations for seed certification. Apart from the above, theft of certified cassava seed from the VSEs field in locations where sharing is not a norm is a source of worry to VSEs. At the moment, the traditional institution has not been able to address this properly so as to make the people understand that cassava seed multiplication is now a business especially among the rural farming populace.

Conclusion

Building a Sustainable and Integrated Cassava Seed System is a project that seeks to develop a formal cassava seed system in Nigeria. One key strategy to achieving this is the village seed entrepreneur model as drivers of change in the rural farming communities. These carefully selected champions of cassava seed multiplication and marketers are expected to bring about the desired change from the already existing informal seed system for cassava to the much desired formal seed system. A formal seed system for cassava has great potentials as a business model. Apart from increasing incomes to VSEs, the gap between actual yields from the farmers' fields and potential yields will narrow down significantly in Nigeria. To achieve this in a developing seed system environment will certainly be faced with some inherent challenges, but with synergy among the operators in the system, a lot will be achieved. It is therefore suggested that a more aggressive sensitization programmes such as the use of radio jingles and market day promos be intensified to popularize the village seed entrepreneurs in the communities and possibly enlarge the number of existing participants.

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Access and Utilization of Agricultural Insurance among Farmers in Orlu Local Government Area of Imo State, Nigeria

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Abstract
This study analyzed the level of access and utilization of Agricultural insurance scheme among farmers in Orlu LGA of Imo state. Data were collected with the aid of a structured questionnaire using a multistage random sampling procedure to select 60 respondents from the study area. Descriptive statistical tools, likert scale, Z test and simple regression were used to analyze the data obtained. Results from the study showed some levels of participation in the insurance scheme by the farmers. The results of the simple regression analysis showed that access to credit increases by ₦0.84 with each additional increase in insurance. Insufficient income, lack of agricultural disbursement, lack of security and high interest rates were the major factors affecting farmers' access to credit. Therefore, there is need for policies aimed at the establishment of insurance companies and agricultural and micro finance banks in the study area which will facilitate the farmer's access to credit to help boost their capital base.
Keywords: Agricultural Insurance, farmers, Credit, and Orlu LGA

Introduction
Agriculture remains an important economic sector in many developing countries. It is a source of growth and a potential source of investment opportunities for the private sector. Approximately three-quarters of the world's agricultural value added is estimated to be created in developing countries with agriculture contributing as much as 30 percent to gross domestic product (GDP) (FAO, 2012). Agriculture is a risky enterprise due to its cyclical nature, risk of loss from fires and natural disasters. More so, agriculture is particularly exposed to adverse natural events; such as droughts, floods, pest and diseases and the economic cost of major disasters may even increase in the future because of climate change; this unexpected event or loss can lead farmers to poverty if not checked. Agricultural insurance is a variable tool that agricultural producers can use to adapt and even mitigate the risk associated with their business. According to Ajieh, (2010), agricultural insurance is an economic component of farm management designed to reduce the adverse effect of natural disaster on farmers' income through the payment of indemnity. The Federal Government of Nigeria introduced agricultural insurance scheme in order to broaden farmer's access to farm resources and change their attitude to risk in the choice of resource use positively. Specifically NAIC was established for farmers to have more access to essential farm resources that would motivate them to embrace the use of modern farm practices with the assumption that such practice will lead to increase the quantity and quality of farm production and food supplies to the market (Olubiyo et. al., 2009). This is possible because the policy holders are assured of a certain income in a case of crop and livestock failure. Several studies have shown that agricultural insurance not only protects farmers against financial disaster (and closing of the business) after suffering any of the insured risks but also empowers the farmers to obtain farm credit (Olubiyo and Hill, 2003; Arene, 2005; Epetimehin, 2010). However, the Nigerian farmers are not really excited about taking an insurance policy which may be due to the unsatisfactory image of the insurance industry regarding loss compensations. In addition, the low income, small sizes of enterprises, large scale ignorance, poverty and the adverse view of other people's experiences with activities of insurance companies in other sectors have made farmers reluctant to patronize the

scheme, let alone agree to pay the small premiums in exchange for their farm risks (Olubiyo et. al 2009; Akintunde, 2015). Nevertheless, crop insurance is important for the adequate supply of credit to farmers, it gives assurance that farmer will be able to repay their operating loans in the event of weather or price related calamities as stated by Jeff Gerhert (2012). This has necessitated the study on the level of access and utilization of agricultural insurance in Orlu local government area of Imo State, Nigeria. The specific objectives are to ascertain the farmer's level of participation in the agricultural insurance schemes, compare the amount of credit received by insured and non-insured farmers, determine the effect of insurance on access to credit and also identify the constraints militating against access to credit.

Methodology

The study was carried out in Orlu local government area of Imo state. Farming is the predominant occupation of the people in the state. The farmers practice mixed farming as well as mixed cropping. A multistage random sampling technique was used to select sample respondents to analyze the level of access and utilization of agricultural insurance in Orlu local government area of Imo State. Three communities were randomly selected from the study area. Secondly, two villages were randomly selected from each of the communities giving a total of six villages. The third stage involved the random selection of seven insured and seven uninsured farmers from each of the six villages giving a total of 84 respondents. However, only 24 insured farmers' and 32 insured farmers' questionnaires were retrieved giving a total of sixty respondents for the study. Data were collected from primary sources with the use of structured questionnaire designed in line with the objective of the study. The farmers' level of participation in agricultural insurance scheme was analyzed using likert scale. The 4-point likert scale had legends ranging from Very high = 4; High = 3; Low = 2; Very low = 1. This was used to determine the mean score on responses of the level of participation

$$\text{Mean score} = \frac{4+3+2+1}{4} = 2.5$$

Ƶ-test was used to compare the amount of credit received by insured and uninsured farmers and is given thus:

$$Ƶ = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{S_1^2/N_1 + S_2^2/N_2}} \qquad (1)$$

Where
Ƶ = Ƶ-test
X1 = mean level of access to credit by insured farmers.
X2 = mean level of access to credit by uninsured farmers.
$S^2{}_1$ = Standard deviation of credit level of insured farmers.
$S^2{}_2$ = Standard deviation of the credit level of uninsured farmers.
N_1 = Number of insured farmers
N_2 = Number of uninsured farmers
Simple regression model was used to analyze the effect of insurance on access to credit and is specified thus:

$$y_1 = b_0 + b_1 x_1 + e_1 \qquad (2)$$

Where;
y_1 = Access to credit
x_1 = Insurance (1=access, 0=otherwise)
b_o = Constant
b_1 = Slope coefficient
e_1 = error term

The 4-point likert scale had legends ranging from Strongly Agree = 4, Agree = 3, Disagree = 2 and Stongly Disagree = 1. This was used to determine the mean score on responses of constraints militating against farmers' access to credit.

$$\text{Mean score} = \frac{4+3+2+1}{4} = 2.5$$

Results and Discussion

Level of Participation in Agricultural Insurance Scheme

The likert scale was used to determine the mean score on responses of the level of participation in agricultural insurance scheme. The result of the analysis is presented in Table 1.

Table 1: level of participation in insurance scheme

Insurance scheme	VH	H	L	VL	Score	Mean	Decision
Whole farm insurance	32	8	3	12	201	2.92	VH
Fixed insurance	30	15	5	10	204	2.97	VH
Revenue insurance	2	10	30	12	175	2.32	H
Income insurance	5	5	15	35	85	1.42	VL
Yield insurance	5	10	20	25	115	1.92	L
Combined insurance	0	0	20	40		1.47	VL

Source: Field Survey

VH, H, L, VL represents very high, high, low and very low respectively.

The perception of the respondents on the level of participation in agricultural insurance scheme in the study area is presented in Table 1. The result shows that the respondents' participation in whole farm insurance (2.92) and fixed insurance (2.97) were very high followed revenue insurance (2.32). The income insurance and combined insurance with mean of 1.42 and 1.47 respectively had very low level of participation in the study area. This implies that the respondents are not fully aware of the other insurance schemes available.

Comparison of the amount of Credit received by Insured and Uninsured Farmers

$\underline{X}_1$ = mean level of access to credit by insured farmers = 26.87

$\underline{X}_2$= mean level of access to credit by uninsured farmers = 24.274

$S^2{}_1$= standard deviation of credit level of insured farmers = 17.193

$S^2{}_2$= standard deviation of the credit level of uninsured farmers = 14.778

N_1= number of insured farmers = 24

N_2= number of uninsured farmers = 32

Z = 0.877.

The Z test carried out above indicated a Z value of 2.877 which was significant at 5% level indicating significant difference in the credit level of insured farmers and the credit level of uninsured farmers. This implies that, participation in agricultural insurance scheme in the study area gives the farmers more access to credit than non-participation. This will result to high resource use efficiency, reduced cost of production and increased production capital on the side of the insured farmers and high cost of production, lack of capital on the side of the uninsured farmers in the study area.

Effect of Insurance on Access to Credit in the Study Area

In fitting the functional form, regression analysis was employed and the estimated result is shown in Table 2.

Table 2: Effect of Insurance on Access to Credit

Variable	Coefficient	Standard error
Constant	5.00	11.3***
Insurance	0.75	13.8***
R2	0.84	
F- ratio	12.94***	

***, ** represents 1%, 5% and levels of probability respectively

From the simple regression result on the effect of insurance on access to credit in the study area, the R-squared value of 0.84 means that the independent variable (insurance) contributed to access to credit variability by 84%. The remaining 16% is influenced by other factors. This is in conformity with Olubiyo et al., (2009) who opined that availability of insurance scheme grants farmers access to credit but did not necessarily translate to increased output due to some other factors. On the hand, the equation of the access to credit is, $Y = 5.00 + 0.84 X_1$. This suggests that access to credit increases with ₦0.84 with each additional increase in insurance.

Constraints to Access to Credit in the Study Area

The problem encountered by farmers in obtaining credit from sources is shown in Table 3.

Table 3: Constraints to Access to Credit

	Constraints	SA(4)	A(3)	D(2)	SD(1)	Score	Mean	Decision
1	Lack of Agric credit disbursement	5	10	10	35	160	2. 58	A
2	Much documentation	5	10	20	25	115	1.85	D
3	Insufficient income	25	10	10	15	165	2.75	A
4	Lack of security	15	18	12	15	153	2.55	A
5	High interest rate	22	15	0	23	1	2. 50	A

Source: Field Survey

From the result on the constraints militating against access to credit, constraints such as insufficient income, lack of agricultural credit disbursement, lack of security and high interest rate with mean of 2.75, 2.58, 2.55 and 2.50 respectively are the major factors affecting farmer's access to credit in the study area, while much documentation with mean of 1.85 is the least affecting challenge of farmers access to credit in the study area.

Conclusion

Insurance and other risk transfer solutions can be part of a systemic adaptation approach and can enable vulnerable countries to better manage the risks associated with agricultural business. Insurance can provide financial security against the economic impacts of extreme climate events and many for be more cost effective that certain prevention measures. This study indicated a higher level of participation of the farmers in whole farm and fixed insurance scheme which significantly affected their access to credit in the study area. Also, the findings showed that insufficient income, lack of agricultural credit disbursement, lack of security and high interest rate as the differentials in farmers' level of access to credit. Therefore, the establishment of insurance companies, agricultural and micro finance bank in the study area which will facilitate the farmer's access to credit to help boost their capital base is highly recommended.

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Analyses of Cassava Processing and Profitability among Small-Holder Cassava Farmers in Abia State, Nigeria

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Abstract
This study analysed cassava processing and its profitability among smallholder cassava farmers in Abia State, Nigeria. Data used for the study were obtained from 120 respondents using a multistage sampling technique. The data was analysed by the use of descriptive statistics and cost and returns analysis which showed that the estimated cost was N250,465 while the estimated total revenue was N544,490. For the gari enterprise, result of the analysis showed a gross margin of ₦326,814.53/tonne and an estimated Net income (NI) of N294 ,025.19. Furthermore, the estimated profitability index (PI) of 0.5400 implies that for every N 1.00 earned as revenue N1.54 were returned as net income . Hence, the cassava processing enterprise was profitable. The rate of return on investment (ROI) was calculated as a percentage ratio of the net income to the total cost (TC). The estimated ROI for the gari enterprise was 117.39%. Thus implies that the gari enterprise made more than double the amount on every N1.00 Invested. However cassava processing have some constraints prominent among which include; inadequate capital, high cost of transportation, high input price, high interest rate, high cost of labour, provision of credit support to investors in cassava processing not only as an agricultural loan but small and medium scale enterprise (SMEs). Access to grant to expand their capacities, adopt new technologies / innovation, improve scale of operations and income are recommended for increased processing.
Keywords: Cassava, Processing, Profitability, and Small-Holders Farmers

Introduction
Cassava (*manihot esculata*) has been acknowledged as one of the most popular staple crops in the Africa diet (Nweke *et al,* 2003). It production is characterised by small scale producers who use old varieties and traditional production technologies which largely accounts for how yield. Abia State accounts for 634 metric tonnes of cassava Annually (NBS, 2007). The crop is produced mainly in fresh and processed forms starting from the producers through myriads of processors to the end users. Acceptance of cassavas low cost food in urban centres and as a source of steady income for rural households, depend on how it can be processed into a safe form (Bokanga, 2005). It stands to gain in domestic demand as well as a potential export, if it can be processed in more efficient manner depend on how it can be presented to urban consumers in an attractive form at prices which are competitive with those of wheat cereal and yam. In addition if producers could harvest cassava and process then into staple commodities (such as gari), that could be stored for several months, they could earn higher profits during the period of scarcity. The acquisition of simple processing equipment is an investment which the majority of the small scale cassava processors cannot afford; consequently, poor credit facilities and high interest rate make such investment risky and financially unattractive and hinder the development of the economic potentials of the crop. More so, the inability to analyse effectively the cost benefit returns from the activity, with poor access to productive inputs according to Oyewole and Philip (2006) stagnate expansion and expansion and investment opportunities. Therefore this study analysed the cost and returns for cassava processing into gari and identified the constraints militating against the enterprise in the study area.

Methodology

The study was carried out in Abia State, Nigeria. The zone lies between latitude 4^0 45^1 and 06^0 and 06^0 and 17^0 N longitude 07^0 00 and 08^0 00 East of equator (Abia ADP, 2005). It has seventeen (17) Local Government Areas. Cassava production is a common business in the zone, usually processed into different forms like gari, fufu, abacha, flour, chips and starch. A multi-stage sampling technique was used to randomly select 120 processors from four LGAs in the state. Data were collected from primary source and a structured questionnaire was designed in line with the objectives of the study. Data collected were analyzed using budgetary technique and descriptive statistics. Budgetary technique was used to estimate the gross margin, profitability index, rate of return on investment, operating expenses, net income and benefit cost ratio. The gross margin technique was given thus;

$$GM = GR - TVC \qquad (1)$$

Where;
GM = gross margin in naira per kg
GR = gross revenue in naira
TVC = total variable cost in naira
The result of the budgetary analysis was used to obtain the following ratios:

$$PI = \text{profitability index} = NI/TR \qquad (2)$$

$$RRR = \text{rate of return on investment} = \frac{NI}{TC} \times \frac{100}{1} \qquad (3)$$

$$OR = \text{operating expenses ration} = \frac{TVC}{TR} \qquad (4)$$

Where;
NI = net income
TR = total revenue,
TC = total cost,
TFC = total fixed cost
TVC = total variable cost

Results and Discussion

Profitability analyses of cassava processing

The budgetary technique was used to analyze the profitability of cassava processing into gari while BC ratio, profit index and rate of return on investment were calculated. The result of the analysis presented in Table 1 showed that the cost incurred in cassava processing includes cost of raw materials, labour and cost of depreciated assets. An average of 2730.63kg of cassava was processed into gari and accounted for 29.17% of TVC, and 25.35% of TC of labour. The estimated total cost was N250,465 and total revenue of N544,490.94 for the gari enterprise. Result of the analysis showed a gross margin of N326, 814.53/tonne and estimated net income of N294,02.519. Furthermore, the estimated profitability index (PI) of 0.5400, implies that 54% of total revenue generated constituted net income for the gari enterprise and for every N1.00 earned as revenue, 54 kobo were returned as net income. Hence, the cassava processing enterprise was profitable. The rate of return on investment (ROI) was calculated as a % ratio of the net income to the total cost (TC) return on investment as 117.39%, implying that the gari enterprise made more than double the amount on every N1.00 invested. This could also be seen in the estimated benefit cost ratio for the enterprise. For every N100 spent there was a return of N1.17 in the enterprise. This confirms the findings of Elunmove *et al.* (2015) that the processing of cassava is profitable, return of benefit cost ratio between 1.75 and 2.24 in Abia State Nigeria. Operating Ratio (OR) profitability indicators which measure the percentage of variable cost per N1.00 sale/revenue to the percentage of variable cost was 40%. This could be attributed to the prices and qualities of the inputs of variable cost items used in the production process.

Constraints to Gari Production

Gari production in the study area is faced with numerous challenges affecting it productivity which can also result to various levels of inefficiencies. The problem associated with gari production is the study area include; inadequate capital, high cost of labour, high cost of transportation lack of processing and storage equipment among others. Findings from Table 2 showed that inadequate capital, high cost of transportation, high cost of input, high interest rate and high cost of labour were major constraints militating against cassava processing in the study area. Capital serves as a major backbone in any business enterprise. High cost of capital ranked the highest followed by high cost of transportation

Conclusion

Based on the findings, the enterprise was profitable at varying levels with gari and abacha enterprise returning more than double the amount invested in them. While problems such as inadequate capital, high transportation costs, high input prices, high interest rates and high cost of labour were most of the important constraints militating against cassava processing in the State. The study therefore calls for policies aimed at provision of credit support at little or no interest rates to invest in cassava processing and expand their capacities. Need for provision of social amenities especially rural access roads to reduce the transactions cost in cassava production and processing.

Table 1: Cost and retune analysis for cassava processing into garri in a study area

Item		Garri value
A	Revenue	544490.94
B	Variable cost items (N)	
	Cassava root	63487.15
	Other raw material cost	4818.28
	Labour cost	82370.98
	Total variable cost TVC	21767.74
C	Fixed cost items (N)	
	Grater	50083.70
	Weight scale	
	Others	
	Total fixed cost (TFC)	113862.99
	Depreciation	163946.69
	Total cost	32789.34
	Net income (NI) = TR-TC	250465.75
	Gross margin (revenue-TVC)	326814.53
	Benefit cost ratio	2.17:1.00
	Profitability index = Ni/TR	0.5400
	% Net profit to total sales/revenue	54%
	Rate on return of investment (%) NI/TC x $\frac{100}{1}$	117.39%
	Operating ratio (TV/TR)	0.3998

Source: field survey, 2017

Table 2: problems affecting cassava production

Challenge	Frequency	Percentage (%)	Ranking
Inadequate capital	78	65	1
High cost of labour	55	45.83	5
Lack of market outlet	20	16.67	9
Weather condition	74	11.67	11
High transportation	65	54.17	2
Lack of basic amenities	40	33.33	6
High input prices	64	53.33	3
Lack of processing/storage	39	32.5	7
High interest rate	61	50.83	4
Lack of extension services	15	12.5	10
Low level of income	20	16.67	9
Inconsistent govt. policies	32	26.67	8

Source: Field survey, 2017
*multiple responses

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SUB-THEME 2

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Response of Lettuce (*Lactuca sativa* L.) to Poultry Manure Rates and Sources of Green Manure at Samaru

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Abstract
A pot experiment was conducted at the Orchard of the Department of Agronomy, Faculty of Agriculture, Ahmadu Bello University, Zaria during the 2016 rainy season to study the response of lettuce to rates of poultry manure and three types of green manure. The treatments consisted of three rates of poultry manure (0, 2, and 4 t ha^{-1}) and three types of green manure plants (Soyabean, Mucuna, and Lablab). The treatments were factorially combined and arranged in a Randomised Complete Block Design (RCBD) and replicated three times. An increase in the level of poultry manure application application gave a corresponding increase in the plant height, number of leaves and fresh weight at harvest. There were significant differences in the plant height, number of leaves and fresh weight at harvest of lettuce due to the type of green manure with lablab having the highest values for growth and yield parameters. Regression analysis of poultry manure with the yield of lettuce indicated a linear response which means that the optimum poultry manure rate was not attained. Therefore it can be concluded that 4 t ha^{-1} of poultry manure and in combination with lablab as green manure is sufficient for lettuce production at Samaru.

Introduction
Lettuce *(Lactuca sativa L.*) is one of the most important salad crop that is grown worldwide and a native of Europe, Asia and North Africa (Ananda and Ahundeniya 2012). The plant grows well on a wide variety of soils, ranging from light sand to heavy clay. However the best results are obtained on fertile loams that are rich in organic matter. A pH of between 5.5 and 7.0 is optimum (Valenzua *et al.,* 2012). Lettuce is used mainly in salads however, the leaves may be boiled like spinach and is frequently used in sandwiches. Regular inclusions of lettuce in the diet is known to prevent osteoporosis, anaemia and believed to protect from cardiovascular diseases, alzheimers disease and cardiovascular diseases and cancer (USDA, 2016). The productivity and quality of lettuce depends on the growing conditions and soil amendments such as poultry manure, green manure and farmyard manure. Organic vegetable growing has its attendant benefits among which includes, tastier and healthier vegetables that are better than chemically grown ones. The soil nutrient status is also maintained and improved. The quality and quantity of fertilizers applied are key factors affecting the growth, yield and quality of plants however excessive amounts are applied to vegetables in order to achieve maximum yield (Stewart *et al*., 2005). Thus, organic manure can serve as alternative practice to inorganic fertilizers for improving soil structure, reducing the amount of toxic substances such as nitrates produced by conventional fertilizers in vegetables hence improving the quality of leafy vegetables inclusive of lettuce as well as human health. Organically grown fruits and vegetables contain more minerals and vitamins than conventionally grown ones (Worthington, 2001). Therefore the productivity and quality of vegetables especially lettuce depends on the growing conditions and fertilizer applications.

Materials and Methods
A pot experiment was carried out at the orchard of the Department of Agronomy, Ahmadu Bello University, Zaria. (11^{0}11'N 7^0 38^{0}E) and 686m above sea level in the northern guinea savanna ecological zone of Nigeria, The treatments consisted of three rates of poultry manure (0, 2 and 4 tons^{-1}) and three (3) green manure sources (soyabean, mucuna and lablab) factorially combined

and arranged in Randomised Complete Block Design (RCBD) replicated three(3) times. The lettuce variety used was Eden. It is tolerant to heat and bolting, tolerant to necrosis, makes a large compact forming head. The soil was collected from the research farm of the Institute of Agricultural Research (IAR) Samaru Zaria and analysed before placement in pots as per treatment and allowed to decompose in the soil for two (2) weeks. The three legumes were sown as per treatment and at 8 weeks after sowing (WAS) they were harvested and analysed for their chemical components before incorporation in to the pots as green manure as per treatment. Seeds of lettuce were sown manually by broadcasting on 8th July 2016. Weeds were frequently hand pulled carefully from each pot to avoid damage to crops. There was no incidence of pests and diseases observed during the period of the experiment. Harvesting was done at 56 WAS and yield parameters were taken by uprooting the entire crop. Two crops were tagged in each pot and measurements of plant height, number of leaves and fresh plant weight were taken. The height of the crop was taken from the ground level of the plant to the apex using a metre rule, the number of leaves were counted and the average was obtained and recorded. All plants in the pots were harvested and the fresh weight was taken using a Mettler Toledo SB16001 electronic weighing balance.

Results and Discussion

Table 1 shows the chemical composition of the soil amendment applied. Nitrogen content was found to be higher in poultry manure followed by that from Lablab then Mucuna and the least was from Soybean. Table 2 shows the growth and yield of lettuce as influenced by poultry manure and green manure at Samaru. Poultry manure significantly influenced the parameters. Application of 2 t ha^{-1} of poultry manure significantly increased the plant height and number of leaves of lettuce similar trend was observed with 4 t ha^{-1}. There was a corresponding increase in the fresh weight at harvest with increasing poultry manure from 0 to 4 t ha^{-1}. The use of different sources of green manure significantly influenced the plant height and fresh weight at harvest of lettuce. Where Lablab and Soybean produced comparably taller plants than Mucuna while the use of lablab as green manure produced significantly the heaviest plant fresh weight followed by that from the use of soybean and the least was when Mucuna was used. The significant interactions between poultry manure and green manure on the number of leaves and plant fresh weight of lettuce is presented in Table 3. When Mucuna and lablab were used application of 2 t ha^{-1} poultry manure gave a significant increase in number of leaves of lettuce. However beyond this rate no significant improvement in this parameter was observed but when soybean green manure was used varying the rate of poultry manure did not significantly influence leaf production. At fixed manure rate of 0 t ha^{-1}, use of soybean green manure resulted in more leaf production only than for mucuna or lablab but when 2 t ha^{-1} of poultry manure was applied, leaf production where either mucuna or lablab green manure was incorporated were similar and more than for the soybean. When the highest poultry manure rate of 4 t ha^{-1} was considered varying the source of green manure had no significant effect on leaf production. The interaction between poultry manure and green manure on plant fresh weight. (Table 3). At fixed poultry manure rate 0 t ha^{-1}, the use of Lablab as green manure resulted in similar plant fresh weight with that of Soybean though heavier than Mucuna. When 2 and 4 t ha^{-1} poultry manure were considered, Lablab still had heavier fresh plant weight than for other sources of green manure. Application of 2 t ha^{-1} poultry manure and further increase to 4 t ha^{-1} significantly enhanced plant fresh weight of lettuce regardless of the source of green manure. A combination of 4 t ha^{-1} of poultry manure and lablab significantly produced the heaviest plant fresh weight while the interaction of 0 t ha^{-1} and Mucuna produced the least plant fresh weight. The positive influence of poultry manure on virtually all the parameters of the crop might be due to the release and use of the nutrients contained in the poultry manure. This result confirms the Masarirambi *et al*., (2012) from the results of an experiment conducted showed that the chicken manure levels significantly affected the growth, yield and nutritional quality of lettuce. The low fertility status of the soil on which the experiment might have been the reason for the positive response response of the crop to the applied poultry manure rates. The significant differences in plant height and fresh weight of lettuce as result of using different sources of green manure could be attributed to the high N content of the Lablab. Another positive effect of green manure on lettuce could be partly associated with the amounts of plant nutrients in general and nitrogen in particular, returned to soil biomass (Shah *et al.*, 2011). The higher values for number of leaves as well as plant fresh weight observed by the combination of the poultry manure and lablab could be as a result of the fact that both poultry manure and lablab green manure were very rich in nitrogen which is a key element for higher vegetable yield and quality and it is involved in all parts of the plants metabolic processes and its rate of uptake and partition being largely determined by supply and demand during the stages of plant growth (Delogua *et al*., 1998).

Conclusion

Based on the results obtained it can be concluded that application of 4 t ha^{-1} poultry manure and the use of lablab as green manure resulted in a good crop of lettuce.

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Table 1: Chemical composition of Poultry manure and green manure plant materials used for the study

Chemical composition	Value
Poultry manure	
Total Nitrogen (%)	2.12%
Available Phosphorus (%)	0.041%
Potassium (%)	0.64%
Plant Tissue	**Nitrogen content (%)**
Lablab	1.74
Mucuna	1.28
Soybeans	1.34

Source: Department of Soil Science, Ahmadu Bello University, Zaria

Table 2: Growth and yield of Lettuce as influenced by poultry manure and green manure in 2016 rainy season

Treatment	Plant Height(cm) (at 7 WAS)	Number of leaves (at 7WAS)	Fresh weight at harvest (g)
Poultry manure rates (P) t ha^{-1}			
0	12.64b	12.00b	40.29c
2	16.83a	21.00a	108.26b
4	16.93a	21.00a	188.38a
SE±	0.505	1.477	2.892
Green manure sources (G)			
Mucuna	13.43b	19.00	86.70c
Lablab	17.19a	18.00	138.36a
Soybean	15.79a	17.00	111.87b
SE±	0.505	1.477	2.892
Interaction			
P X G	NS	*	* *

Means followed by the letter(s) within a treatment group are not significantly different at 0.05 level of probability using DMRT. NS = Not significant

Table 3: Interaction of poultry manure and sources of green manure on the number of leaves and plant weight at 7 WAS during the 2016 rainy season

	Poultry manure (P) t ha^{-1})		
Green manure(G)	0	2	4
	Number of leaves		
Mucuna	8.33d	26.00a	23.00ab
Lablab	12.33cd	20.33ab	20.33b
Soybean	16.00c	15.67cd	19.00bc
SE±	2.56		
	Fresh yield (kg ha^{-1})		
Mucuna	15.97g	69.73e	173.40bc
Lablab	56.17ef	156.33c	202.57a
Soybean	48.73fg	98.70d	188.17b
SE±	0.78		

Means followed by the letter(s) within a treatment group are not significantly different at 0.05 level of probability using DMRT. NS = Not significant

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Effect of Sett-size and Spacing on the Yield of White Yam (*Dioscorea rotundata*) in Umudike, Abia State, Nigeria

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Abstract
The experiment was conducted at National Root Crops Research Institute Umudike Southeastern Nigeria to determine the effect of sett-size and spacing on elite landrace of white yam. The variety was Yandu. Parameters assessed were: tuber number, tuber weight (g) and tuber yield (t/ha). Data obtained was subjected to statistical analysis of variance (ANOVA) using Genstat Discovery Edition 3 Statistical package and treatment means was separated by using (LSD) Least Significant Difference at 5% probability level. The result obtained indicated that sett-size of 55g at spacing 1m x 1m gave the highest yield of 4.0 number of tuber per 1000 plants/ha fresh weight of tuber per plot. Also, spacing of 1 x 0.5m and sett-size of 55g gave the highest tuber yield of 27.03 t/ha. These indicate that sett-size of 55g and spacing of 1 x 0.5m could be used in the production of Yandu white yam cultivar.

Key words: Sett-size, spacing, landrace and tuber yield

Introduction
Yam (*Dioscorea species*) is a tuber crop belonging to the family Dioscoreaceae. The species of economic importance include (*Dioscorea rotundata*), (*Dioscorea alata*), (*Dioscorea cayenensis*), (*Dioscorea dumentorum*), (*Dioscorea bulbifera*), (*Dioscorea esculentus*) are most widely cultivated (Akinbo, *et al,* 2016.). It is the most important food and income sources for millions of producers, processors and consumers in West Africa. Yam is also integral to the socio cultural life in the sub-region of the Sahara. Also, yam is a monocotyledonous and annual herbaceous plant and according to Nwankwo, *et al* (2017), yam has a long climbing stems which wind themselves around support. He further reported that a single plant can produce up to five tubers of various shapes which can weigh up to 5kg. Yam is very rich in starch and protein and is a popular tropical food. It grows well where there are light, well drained soils and the most fertile land is used for yam cultivation. Yams are staple food crops in the West Africa except for cereals. Yam can be multiply through the use of mini-sett. A mini-sett is defined as a set of about 25g or less which is one quarter the normal planting set for seed yam production. It will develop to address the problem of high cost of scarcity of seed yam. In traditional, yam growing area, the setts of seed yam are planted in mounds especially made at the end of the rainy season before the soils becomes too hard to work on. The yams are planted during dry season and begin to sprout at the onset of the next rainy season. Stalks are usually provided for the yam vine to climb on by cutting the sticks or dried maize and guinea corn stems (Nwankwo, *et al,* 2017). Harvesting of the tubers starts in the middle or later period prior to rainy season. In the Northern parts of Nigeria where yam growing is new, planting is usually done on ridge and staking is extremely rare. (Akintola, 2008). National Root Crops Research Institute, (Umudike) and IITA, Ibadan developed the mini-sett technique to overcome the critical problems of the unavailability of good quality seed yam by improving the rate of multiplication of white yam (IITA, 1985). The mini-sett technique is by cutting mother seed tubers to smaller sizes with a reasonable amount of peel (periderm) from which sprouting occurs. The mini-sett will be treated with chemical to prevent termite attack and rot. Nevertheless, mini-sett could be used in all yam multiplication. There will be varietal differences in the performance of the mini-sett. Therefore, the objectives of this study were to

determine the effect of sett-size and the effect of spacing on the yield of Yandu white yam cultivar.

Materials and Methods

The trial was conducted at the Eestern farm of National Root Crops Institute, Umudike, (NRCRI) in 2016 and 2017. One white yam cultivar (Yandu) was used. The setts weights were 35g, 45g, 55g and 65g. The land was prepared with tractor, the ridges were spaced 1.0m apart and the tuber setts were planted on the crest of the ridge. The plot size was 4x2m = ($8m^2$) and the number of the treatments were 16. The treatments consist of four levels of sett-size and four levels of spacing which were: 1mx0.25m, 1mx0.5m, 1mx0.75m and 1mx1m. Pre-emergence herbicide (Premextra) was applied complemented with manual weeding to ensure weed free plots. The Experimental Design was Randomized Complete Block Design. Each plot contained 16 plots and replicated 3 times. Each plot was separated from each other with a space of 1m. Fertilizer NPK (15:15:15) was applied by the use of side application method.

Data collection: Data collected include the Number of ware yam, weight of ware yam, number of seed yam, and weight of seed yam, number of tuber per plot and weight of tuber per plot.

Data analysis: The number of tubers per plot were counted and recorded at harvest. All tubers per plot were weighed after harvest and analysis of variance was used (ANOVA). For the tuber yield analysis, treatment means was separated using the LSD (least significant difference) at 5% probability level. The tuber yield was measured in tones per hectare.

Results and Discussion

The effect of sett-size and spacing on the number of tuber of the white yam cultivar in 2016 and 2017 are represented in Table 1(a) and 1(b). In 2016, Table 1(a), there was no significant ($p>0.05$) differences on sett weight of the white yam (Yandu) variety. However, the 1.0m x 0.25m spacing and sett-size of 45g gave the highest number of tuber of 2.21 number of tuber per 1000 plants/ ha. This was followed by 1.0m x 1.0m spacing and of 35g sett-size which gave 2.16 number of tuber per 1000 plants/ ha. There was no significant differences ($p>0.05$) on the interaction of sett weight and spacing. In 2017, Table 1(b), there was significant difference ($p<0.05$) of sett weight of Yandu white yam variety. The 1.0 x 1.0 m spacing and sett-size of 55g gave the highest yield of 4.0 number of tuber per 1000 plants/ ha followed by 1.0 x 0.75m spacing and 45g sett-size which gave 2.09 number of tuber per 1000 plants/ ha. For the spacing, there were no significant differences ($p>0.05$). However, there was significant differences ($p<0.05$) in the interaction on the number of tuber per 1000 plants / ha. Sett-size at 55g and spacing of 1 x1 m gave the highest yield of 4.0 number of tuber per 1000 plants/ ha. Effect of sett-size and spacing on the tuber weight yield (t/ha) of Yandu white yam cultivar are represented in Table 2(a) and (b). There was no significant ($p>0.05$) differences in the set weight in 2016 (Table 2a). For spacing, there were significant ($p<0.05$) differences. The spacing of 1 x 0.25 m and sett-size of 65g gave the highest tuber weight yield of 23.69t/ha followed by spacing of 1x0.25m and set-size of 35g of the tuber weight yield of 23.23t/ha. For the interaction, there was also no significant ($p>0.05$) differences. In 2017, (Table 2b), there was significant difference in both sett weight, spacing and the interaction. The 55g sett size and spacing of 1x0.5m gave the highest fresh tuber weight yield of 38.70t/ha, followed by sett-size 35g and spacing of 1 x 0.25m with the tuber weight yield of 23.80t/ha. For the interaction, sett weight of 55g and spacing of 1 x 0.5m gave the highest fresh tuber weight yield of 38.70t/ha. There was high significant ($P<0.01$) differences in the spacing for the planting of Yandu variety. The spacing of 1x 0.25m gave the mean yield of 15.46t/ha, followed by the spacing of 1x0.50m which also gave the yield of 15.93t/ha. When the spacing was increased to 1x0.75m and 1 x 1.0m, the tuber yield dropped to 5.54 and 6.14t/ha respectively. This indicated that the wider the spacing, the lower the yield. So, for Yandu variety, smaller spacing gave the higher yield of tubers (Table 3). To obtained the maximum yield of tuber, planting at the space of 1x0.5m gave the highest yield of 27.03t/ha and this is hereby recommended for Yandu variety production. The high significant ($p<0.01$) differences obtained from the sett-size indicated that the sett-size of 35.0g gave the mean yield of 12.94t/ha while the sett-size of 45.0g gave tuber yield of 8.69t/ha. Also, sett-size of 55.0g gave the tuber yield of 13.09t/ha while the sett-size of 65.0g gave the tuber yield of 8.35t/ha. This showed that environmental factor might have had effect on the tuber sizes which affected the tuber yield. However, the tuber size of 55.0g at the spacing of 1x0.5m gave the highest tuber yield of 27.03t/ha. The tuber size and planting space is hereby recommended for the cultivation of the white yam, Yandu.

Table 1(a): Effect of sett-size and spacing on the number of tuber/ plant of Yandu white yam for 2016

		Sett-size (g)			
Spacing (m)	**35**	**45**	**55**	**65**	**Mean**
1x0.25	1.49	2.21	1.96	1.48	1.79
1x0.50	2.01	1.58	1.94	1.39	1.73
1x0.75	1.79	1.46	1.53	1.53	1.58
1x1	2.16	1.61	1.80	1.79	1.84
Mean	1.86	1.71	1.81	1.55	

Table 1(b): Effect of sett-size and spacing on the number of tubers/ plant of Yandu white yam for 2017

		Sett-size (g)			
Spacing (m)	**35**	**45**	**55**	**65**	**Mean**
1x0.25	1.00	1.32	1.14	1.28	1.18
1x0.50	1.00	1.30	1.47	1.50	1.32
1x0.75	1.58	2.09	1.62	1.28	1.64
1x1	1.11	1.00	4.00	1.60	1.93
Mean	1.17	1.43	2.06	1.41	

		2016	**2017**
$LSD_{(0.05)}$ for set weight W means	=	NS	0.65
$LSD_{(0.05)}$ for spacing S means	=	NS	NS
$LSD_{(0.05)}$ for W X S means	=	NS	1.30

Table 2 (a): Effect of sett-size and spacing on the tuber weight yield (kg) of Yandu white yam cultivar for 2016

		Sett-size (g)			
Spacing (m)	**35**	**45**	**55**	**65**	**Mean**
1x0.25	23.23	17.18	20.95	23.69	21.26
1x0.5	17.79	9.08	15.40	8.43	12.68
1x0.75	4.50	11.96	4.18	8.84	7.37
1x1	8.24	8.62	5.78	5.28	6.98
Mean	13.44	11.71	11.58	11.56	

Table 2 (b): Effect of sett-size and spacing on the tuber weight yield (kg) of Yandu white yam cultivar for 2017

		Sett-size (g)			
Spacing (m)	**35**	**45**	**55**	**65**	**Mean**
1x0.25	23.80	5.20	7.80	1.90	9.70
1x0.5	17.30	12.50	38.70	8.30	19.20
1x0.75	2.30	2.00	6.60	3.90	3.70
1x1	6.40	2.90	5.40	6.60	5.30
Mean	12.40	5.70	14.60	5.10	

		2016	**2017**
$LSD_{(0.05)}$ for set weight W means	=	NS	7.52
$LSD_{(0.05)}$ for spacing S means	=	4.70	7.52
$LSD_{(0.05)}$ for W X S means	=	NS	15.03

Table 3: The effect of sett-size and spacing on the mean tuber yield (t/ha) of Yandu white yam cultivar (2016 and 2017)

Spacing (m)	Sett-size (g)				
	35.0	45.0	55.0	65.0	Mean
1 x 0.25	23.49	11.20	14.32	12.77	15.46
1 x 0.5	17.53	10.81	27.03	8.36	15.93
1 x 0.75	3.42	6.99	5.38	6.35	5.54
1 x 1	7.30	5.76	5.59	5.92	6.14
Mean	12.94	8.69	13.09	8.35	
LSD $_{(0.05)}$					
Year		5.675			
Spacing		4.890			
Sett- size		4.325			
Spacing x Sett-size		8.706			
Year x Spacing		6.548			
Year x Sett-size		6.018			
Year x Spacing x Sett-size		61.51			
SV			**ms**		
			163.38*		
Spacing (m)			779.31**		
Year x Spacing			332.20**		
Sett-size (g)			162.17**		
Year x Sett-size (g)			121.23*		
Year x Spacing x Sett-size			83.83*		

Conclusion

Based on the result obtained, the sett-size of 55.0g and spacing of 1x0.5m that gave the highest tuber weight yield of 27.03t/ha. Therefore, it should be recommended and used in the production of Yandu white yam cultivar.

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Evaluation of Five Pre-Emergence Herbicides for Effective Weed Control in Cocoyam (*Colocasia Esculenta (L.*) Schott) Farm, Umudike, Abia State

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Abstract
The field experiment was conducted at the Research farm of National Root Crops Research Institute, (NRCRI) Umudike (05°, 29N, 07°, 31E and 122M above sea level) in 2015 and 2016 cropping season to identify effective herbicides and rate for weed control in cocoyam production. There were 12 treatments consisted of five preemergence herbicides with rates, namely: Dunon at 3L/ha, Diuron at 4L/ha, Goal Tender 4F at 0.5L/ha, Goal tender at 0.75L/ha, Liberator forte at 1L/ha, Liberator forte at 3L/ha, codal Gold at 3L/ha, Codal Gold at 4.5 L/ha, primextra Gold at 3L/ha, Gold at 4.5L/ha, Hoe weeding at 4,8 and 12 WAP and weedy check. The treatments were laid out in a randomized complete block design (RCB) and replicated 3 times with cocoyam variety (Nce 012) as test crop. Application of Goal Tender 4F of 0.5L/ha and goal tender 4F at 0.75L/ha had minimal percentage in jury in both years when compared with other treatments. Goal tender 4F at 0.75 had the lowest weed density, while the unweeded check had the highest weed density. Goal tender 4f at rate 0.75L/ha gave the highest mean yield weight (3.95t/ha) in both years where unneeded check had the lowest mean yield cormel weight (0.38t/ha).

Introduction
There are two main edible types of cocoyam crops of economic importance (Green and Oguzor 2009). They belong to the Araceae family. Cocoyam is probably one of the oldest crop on earth and its domestication is likely to have occurred more than 10,000 years ago. Although some authors (Yen and Wheeler, 19968; Mathews, 1990) considered that cocoyam originated in Indo-Malayan region, between Maynmar and Bangladesh, there is insufficient evidence to confirm this supposition. Nigeria remains the largest producer of cocoyam in the world, with estimated production of 5.49 million metric tons (FAO, 1990), followed by Ghana and China. It is a starchy widely cultivated crop and consumed in south eastern agricultural zone of Nigeria for decades (Ndon *et al.,* 2003). Currently, weeds, pest ad diseases are the most limiting factors in cocoyam production; resulting in significant yield losses in the field and after harvest. Weeds are plants growing where man does not want it to be (Onwueme and Singh, 1998). According to Jackson *et al.,* (2003), weeds account for an estimated 14% loss of yield on worldwide basis. In cocoyam production, weeds have been observed to drastically reduced farmer's yield and constitute a major constraint to cocoyam production in the humid tropics. Hence there is need to identify effective herbicides for weed control in cocoyam production.

Materials and Methods
A field study were conducted at the experimental farm of the National Root Crops Research Institute (NRCRI) Umudike. The cormels were sown on ridges at plant spacing of 100cm by 50cm within and between rows respectively.
Two days after planting, the pre-emergence herbicides were applied using knapsack sprayer for various treatment listed below.

1. Diuron at 3L ai/ha
2. Diuron at 4L ai/ha
3. Goal Tender 4F at 0.5L ai/ha
4. Goal Tender 4F at 0.75L ai/ha
5. Liberator forte at 1L ai/ha

6. Liberator forte at 3L ai/ha
7. Codal Gold at 3L ai/ha
8. Codal Gold at 4.5L ai/ha
9. Primextra Gold at 3 Lai/ha
10. Primextra Gold at 4.5 Lai/ha
11. Hoe weeding at 4,8 and 12 WAP
12. No weeding.

Date collected include; weed density assessment, visual rating of crop injury and cormel weight. The data was subjected to analysis of variance (ANOVA) using the genstate Discovery Edition 12 (Genstat, 2009) and he mean separation was done using least significant difference (LSD).

Results and Discussion

Weeds reduced crop yield and quality. They also decrease the value and productivity of land; reduce harvesting and processing efficiency, increase, cost and labour for control measures. Result showed that all the herbicides applied significantly reduced yield loss in cocoyam when compared to the no weed control treatment. However Goal Tender 4F at both rates proved to be superior among others by significantly lowering the crop injury and also lowering the weed density. In both years, goal tender 4F at 0.75L/ha had comparable weed density with hoe weeding at 8WAP. At 10WAP also, it was observed that Gold Tender 4F at 0.75L/ha gave the least mean value of weed density of apart from hoe weeding. The same trend was observed at 12 and 14WAP. But a significant difference was observed among the treatments.

Conclusion

Application of Goal Tender 4F at 0.5L ai/h and 0.75L ai/ha gave the highest weed control efficacy when compare with the other treatment. Infact, with good weed control, lower crop injury, lower weed density and higher cormel number and weight, Goal Tender 4F at 0.75L/ha can be recommended for weed control in cocoyam especially on mimosa invisa in south eastern Nigeria.

Table 1: Percentage injury rating of cocoyam under different weed control treatment 2015 and 2016

	6 WAP		8WAP		12WAP	
	2015	**2016**	**2015**	**2016**	**2015**	**2016**
Treatment codal gold at 3L/ha	36.7	40.0	34.7	33.3	30.7	33.3
Codal gold 4.5L/ha	40.0	40.0	34.7	31.7	30.0	33.7
Diuron 3L/ha	30.0	30.0	31.3	31.7	30.7	30.7
Diuron 4L/ha	30.0	30.0	31.3	30.0	28.7	30.3
Goal Tender 4F 0.5L/ha	30.0	30.0	31.3	31.3	27.3	30.3
Goal tender 4F 0.75L/ha	30.0	30.0	30.7	30.0	30.0	30.0
Hoe weeding	30.0	44.0	35.0	30.0	30.7	33.7
Liberator forte 1L/ha	40.0	40.0	34.7	31.3	29.3	33.7
Liberator forte 1.5L/ha	40.0	40.0	34.7	32.3	30.7	33.7
Primextra gold 3L/ha	36.7	40.0	34.7	33.3	29.3	33.5
Primextra gold 4L/ha	36.7	40.0	34.6	33.3	32.3	33.5
No weeding	0	0	0	0	0	0
LSD 0.05	1.69	NS	1.5	NS	NS	2.06

Table 2: Effect of herbicides and weeding methods on weed density of cocoyam of 10, 12 and 14WAP in 2015 and 2016

Treatment	10WAP		12WAP		14WAP	
	2015	2016	2015	2016	2015	2016
codal gold at 3L/ha	64.0	56.0	80.0	72.7	90.3	83.3
Codal gold 4.5L/ha	53.0	54.0	68.7	67.0	87.0	76.0
Diuron 3L/ha	61.0	62.0	76.7	77.3	84.3	100.0
Diuron 4L/ha	55.7	63.7	68.7	74.7	77.3	109.0
Goal Tender 4F 05L/ha	46.0	59.7	58.0	78.7	65.7	93.3
Goal Tender 4f 0.75L/ha	37.0	52.0	54.0	72.0	64.3	88.7
Hoe weeding	9.3	26.0	22.0	70.0	24.0	76.3
Liberator forte 1.0 L/ha	61.7	60.7	85.7	69.0	92.0	82.7
Liberator forte 1.5 L/ha	74.0	68.7	95.0	80.0	107.3	97.7
Primextra gold 3L/ha	59.0	68.7	66.0	71.3	81.0	88.0
Primextra gold 4.5L/ha	55.3	59.3	63.7	83.3	70.3	87.7
No weeding	0	0	0	0	0	0
LSD 0.05	10.3	8.5	6.8	5.3	10.9	13.7

Table 3: Effect of weed control treatments o corm weight in 2015 and 2016 (t/ha)

Treatments	2015	2016
Codal gold at 3L/ha	2.77	1.68
Codal gold 4.5L/ha	2.97	1.67
Diuron 3L/ha	2.53	1.45
Diuron 4L/ha	2.33	1.72
Goal Tender 4F 05L/ha	2.57	1.90
Goal Tender 4F 0.75L/ha	2.57	1.72
Hoe weeding	2.02	1.87
Liberator forte 1.0L/ha	2.73	1.93
Liberator forte 1.5L/ha	2.73	1.60
No weeding	1.10	0.15
Primextra gold 3L/ha	2.90	1.60
Primextra gold 4.5L/ha	3.07	1.68
LSD 0.05	NS	NS

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Effect of Some Plant Extracts and Pesticides in the Control of Bacterial Leaf Blight Disease of Cocoyam (*Colocassia esculenta*) in Umudike, South Eastern Nigeria

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Abstract
A pot experiment was carried out in 2010 and 2011 cropping seasons at the screen house of Michael Okpara University of Agriculture, Umudike to determine the Effect of some plant extracts and Pesticides in the control of Bacterial leaf Blight of cocoyam (Colocasia esulenta L) Scholt. The material used include orange peel (citrus sinesis), Bitter cola (Garcinia Kola), Ginger (Zingiber Offlilcinale) streptomycin sulphate (antibiotic), Floraplus (fungicide) and sterile water (control). The experiment was carried out in complete randomized design (CRD) and replicated six times. The plant materials used were first made into aqueous extracts using cold water extraction and diluted to 10% concentration. Application on leaves was by use of hand sprayer for two weekly intervals. Data were collected on disease severity and incidence including growth parameters and on yield of corms. The result obtained showed that all the extracts were able to reduce disease and increase yield better than the control.

Introduction
Cocoyam colocasia esculenta (L.) Scholt constitutes one of the basic food crops of major economic importance in the south eastern Nigeria. It ranks the third after cassava and yam, in terms of total production, land area under crop and consumption (Chukwu and Nwosu, 2008). There are two main edible types of cocoyam in Nigeria Viz: Colocasia esculenta (L) Scholt, otherwise known as “taro” and xanthosoma saggittifoleium also known as tannia (Arene and Ene, 1987). The former is by far more popular than the later. Taro requires heavy fertile upland soil and plentiful rainfall for good yield. It does well also in a fertile low land environment (Agboola, 1987; Anikwe *et al.,* 2007) and commonly grown in South Eastern Zone of Nigeria. Tannia is well cultivated in the South Western zone of Nigeria (Ikwella, 1999).
Colocasia esulenta (taro) is currently threatened to extinction in south eastern Nigeria as a result of its high susceptibility to bacterial leaf blight disease. Therefore this study was undertaken to isolate and identify the cause organism and determines the effect of some selected local plant extracts in the control of bacterial leaf blight of colocasia esculenta.

Materials and Methods
The study was carried out for two years during 2010 and 2011 cropping seasons under pot trials. Top soil was collected from the Eastern farm site of the Michael Okpara University of Agricuture, Umudike. Soil analysis and characterization was conducted to determine the macro ad micro elements and other constituents of the soil.The soil was sterilized and soil, fine sand and poultry droppings respectively (the poultry dropping was allowed to decompose for two weeks before use) and later the sterilized soil mixture dispensed into plastic pots of 15cm in diameter (three, quarter filled). The experiment was arranged in a completely randomized design (CRD) consisting of six treatments and six replications. The plant materials used as extracts were bitter cola ginger, orange peel and two synthetic pesticides, cocoyam corms were planted into experimental pot at the rate of one seedling per pot.

Results and Discussion

This study shows the bactericidal potential and effect of three plant extracts used namely *Garcinia kola*, *Zingiber officinale* and *Citrus sinensis* in comparison with standard pesticides as far as reducing both disease severity and incidence are concerned and at the same time enhancing growth and yield of cocoyam which is an important staple food crop in South Eastern Nigeria. It was noted that the plant extract proved to be as effective as standard synthetic pesticides such as antibiotics (streptomycin sulphate) and fungicide floro plus and were even in some cases at par with these conventional chemicals usually used in disease reduction, indicating that some natural anti-microbial active ingredients are indeed contained in these plant extracts (Stoll, 2000, John and James, 2004). Oparah and Obani (2010) made similar observation in bacterial blight of eggplant. Amadioha (2004) reported that the greater effectiveness of the extracts may be due to inherent chemical constituents or bioactive ingredient of the plant extracts be concluded contain anti-bacterial polyphenolic compounds.

Table 1: Effect of plant extracts on disease severity, growth parameters and yield parameters on colocasia in the pot trial during the 2010 cropping season

Treatment	Disease severity	Leaf Area	No. of leaf	Plant height (cm)	Number corm	Weight of corm/plant ((kg)
Streptomycin	1.33	4.10	4.17	30.67	3.25	2.90
Floro plus	1.67	3.13	3.83	30.33	3.00	2.30
Gargria kola	1.83	2.64	2.50	23.00	3.00	1.70
Zingibar offieinalt	1.33	2.95	3.50	30.00	3.60	2.60
Citrus sinensis peel	1.17	4.83	5.00	31.50	3.85	2.80
Sterile water control	3.00	2.14	2.60	22.17	1.00	1.30
LSD ($P \leq 0.05$)	0.57*	NS	1.81*	6.05**	1.02*	0.80*

* = significant at 5% alpha level ($P \leq 0.05$)
** = significant at 1% alpha level ($P \leq 0.05$)
NS = Not significant

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Effect of Poultry Manure, Time of Introduction of Cowpea Varieties and Clipping on Popcorn (*Zea mays everta* L.) and Cowpea (*Vigna unguiculata* (L.) Walp.) Intercrop at Maigana, Northern Guinea Savannah of Nigeria

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Abstract
The experiment was carried out at Maigana (11º11'N, 07º37'E and 707.6mm above sea level) during the 2013 rainy season. The treatments consisted of four poultry manure rates (0, 2, 4 and 6 tha^{-1}), two cowpea varieties (SAMPEA 6 and Kananado), time of introduction of cowpea (mid June and Mid July) and clipping (clipped and unclipped) laid out in a split plot design and replicated three times. The clipped foliage was incorporated into the soil as green manure. Results obtained showed no significant differences on popcorn parameters in the intercrop but 2tha^{-1} and 6tha^{-1} poultry manure significantly increased cowpea shoot dry weight and canopy width respectively. SAMPEA 6 had higher yield (843.97kgha^{-1}) than Kananado (658.09kgha^{-1}). Wider canopies were also recorded when the cowpea was sown early into the popcorn and unclipped. Significant interactions were recorded between cowpea varieties and their time of introduction on canopy width and shoot dry weight, and also on canopy width between cowpea varieties and clipping, poultry manure, cowpea varieties and clipping. Based on this research, better performance of the intercrop can be obtained by applying 4tha^{-1} of poultry manure with SAMPEA 6 relayed into the popcorn without clipping or applying 6tha^{-1} of poultry manure, sowing SAMPEA 6 early into the popcorn and later clipping it.

Introduction
The sustainability of crop production in the tropics is at a great risk because of the inherent low fertility of the soil and a further decline in the fertility due to intensive cultivation, climate change, high temperature and rates of decomposition of organic matter, leaching, total removal of crop residues and erosion by wind and water (Anon., 2011). These have resulted in degradation of the soil which has also led to low productivity and dwindling food supplies as such creating yield gaps (Pablo and Ken 2013). In an attempt to boost crop production, farmers employ the use of chemical fertilizers but this often result in soil degradation expressed as acidity, nutrient imbalance and loss of soil structure (Cassman, 1999). These problems can however be alleviated by adopting appropriate environmentally friendly and affordable cultural practices that will improve and maintain the soils productive capacity and this can be achieved through intercropping, use of animal manure, compost and green manuring (Heinrich, 2013). Manures have been proven to help amend the soil by improving soil physical, chemical and biological conditions, soil microbial activities as well as soil moisture movement and retention thus ameliorating the soil. The use of manures on the soil also help to feed the soil and allow the soil feed the crops instead of fertilizing the crop alone thus resulting in crops producing at optimum levels and bridging yield gaps (Pablo and Ken 2013). A Popcorn (*Zea mays everta* L.) /cowpea (*Vigna unguiculata* (L.) Walp.) mixture was used to demonstrate the effect of organic manures (poultry manure and green manure) on productivity of the crops in the mixture.

Materials and Methods
The experiment was carried out at Maigana (11º11'N, 07º37'E and 707.6mm above sea level) during the 2013 rainy season. The treatments consisted of four poultry manure rates (0, 2, 4 and 6 tha^{-1}), two cowpea varieties (SAMPEA 6 and Kananado), time of introduction of cowpea (mid

June and Mid July) and clipping (clipped and unclipped) laid out in a split plot design replicated three times. Clipped foliage was incorporated into the soil as green manure. Parameters taken on popcorn were; crop growth rate (CGR), cob weight and yield and on cowpea canopy width, shoot dry weight and yield. Canopy width and shoot dry weight of the cowpea were taken at 12 weeks after sowing. The data collected were summarized and subjected to analysis of variance as described by Snedecor and Cochran (1967) and the treatment means were separated using Duncan Multiple Range Test (DMRT) (Duncan, 1955).

Results and Discussion

The treatments imposed had no significant effect on the crop growth rate (CGR), cob weight and yield of popcorn in the intercrop (Table 1). Also, no significant interactions were recorded between the treatments on the popcorn parameters taken. The cowpea in the mixture however showed significant differences due to some of the treatments imposed. Canopy width significantly increased with increase in poultry manure rates up to 6tha^{-1}. When the cowpea was sown early and unclipped, the canopy width was significantly increased. The shoot dry weight was significantly affected only when poultry manure was applied, where 2tha^{-1} gave the heaviest dry shoots and a significant difference in yield was recorded between the varieties where SAMPEA 6 out yielded Kananando. Significant interactions were observed between cowpea varieties and their time of introduction (V*T) on canopy width and shoot dry weight while cowpea varieties and clipping (V*C) and poultry manure, cowpea varieties and clipping (P*V*C) were observed on shoot dry weight. Table 2 shows that wider canopies were recorded on the two varieties when sown early. Also SAMPEA 6 had the heaviest dry weight when sown early though similar to late sown Kananado. In table 3, wider canopies were recorded on the unclipped plots with SAMPEA 6 having the widest canopies. Table 4 shows that canopy width increased as poultry manure rates increased in both varieties whether clipped or not with unclipped SAMPEA giving the highest at 6tha$^{-1.}$ Increases in canopy width and shoot dry weight of the cowpea in the intercrop with the application of poultry manure can be attributed to its ability to effectively amend the soil by improving the organic carbon content as well as nitrogen, phosphorous and potassium levels of the soil. More so, the increases recorded could be attributed to the shade tolerant ability of cowpea which enables it adapt itself under tall cereals in an intercrop (Kurt 1982). SAMPEA 6 could have out yielded Kananado because it is an improved variety and has better adaptability to the environment than the local cultivar, as local cultivars have been found to be poor in resource capture and utilization. Singh *et al*. (2002) reported that local cultivars recorded significantly lower yield and yield components than improved cultivars which could produce up to 4 tonnes per hectare. Wider canopies and increased shoot dry weight as a result to early planting and non-clipping recorded early in the season could be attributed to higher solar radiation, adequate moisture (rainfall) as well as lower pest pressure in early season Akande *et al*. (2012).

Table 1: Effect of Poultry manure, Cowpea varieties, time of introduction and Clipping on Popcorn and Cowpea at Maigana during 2013 rainy season

Treatments	Popcorn Parameters			Cowpea Parameters		
Poultry manure (P) (tha^{-1})	CGR (gkg^{-1})	Cob weight (g)	Yield ($kgha^{-1}$)	Canopy width(cm)	Shoot dry weight (g)	Yield ($kgha^{-1}$)
0	16.33	46.63	1010.22	90.54c	17.68b	692.20
2	14.92	46.09	973.78	92.73c	28.95a	662.30
4	17.92	45.67	999.78	105.17b	18.38b	768.30
6	16.22	50.10	1078.00	116.01a	22.63b	881.30
SE±	2.493	4.281	97.770	2.762	2.344	83.369
Variety (V)						
SAMPEA 6	17.22	46.63	1021.89	103.90	21.89	843.97a
Kananado	15.48	47.62	1009.00	98.33	21.93	658.09b
SE±	1.763	3.027	69.136	1.953	1.658	58.952
Time of introduction (T)						
Early	15.40	46.11	1001.00	113.43a	23.55	807.85
Late	16.83	48.14	1029.89	88.79b	20.28	694.21
SE±	1.565	1.950	44.938	2.269	1.420	60.961
Clipping (C)						
Clipped	16.07	49.82	1077.78	85.21b	22.41	785.61
Unclipped	16.16	44.42	953.11	117.01a	21.41	716.45
SE±	1.565	1.950	44.938	2.269	1.420	60.961
Interactions						
V*T	NS	NS	NS	**	*	NS
V*C	NS	NS	NS	**	NS	NS
P*V*C	NS	NS	NS	*	NS	NS

Means followed by the same letter(s) within a treatment group are not significantly different at 0.05 level of probability using DMRT

Table 2: Interaction between cowpea varieties and time of introduction on canopy width and shoot dry weight at Maigana during 2013 rainy season

	SAMPEA 6	Kananado
	Canopy width	
Early	109.82a	117.05a
Late	97.98b	79.60c
SE± 3.209		
	Shoot dry weight	
Early	26.74a	20.36bc
Late	17.05c	23.50ab
SE± 2.008		

Means followed by the same letter(s) within a treatment group are not significantly different at 0.05 level of probability using DMRT

Table 3: Interaction between cowpea varieties and clipping on canopy width of cowpea varieties at Maigana during 2013 rainy season

	SAMPEA 6	Kananado
Clipped	81.02c	89.34c
Unclipped	126.72a	107.31b
SE± 3.209		

Means followed by the same letter(s) within a treatment group are not significantly different at 0.05 level of probability using DMRT

Table 4: Interaction of poultry manure, cowpea varieties and clipping on canopy width of cowpea at Maigana during 2013 rainy season

	SAMPEA 6		Kananado	
Poultry manure	Clipped	Unclipped	Clipped	Unclipped
0	66.44e	118.35b	88.66d	88.73d
2	79.78d	113.91bc	77.65de	99.57c
4	87.35d	118.98b	94.73d	119.63b
6	90.76d	155.63a	96.34cd	121.32b
SE± 6.419				

Means followed by the same letter(s) within a treatment group are not significantly different at 0.05 level of probability using DMRT

Conclusion

Based on this research, better performance of the intercrop can be obtained by applying 4tha^{-1} of poultry manure with SAMPEA 6 relayed into the popcorn without clipping or applying 6tha^{-1} of poultry manure, sowing SAMPEA 6 early into the popcorn and later clipping it.

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Efficacy of Some Plant Extracts in the Control of Web Blight of Cowpea

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Abstract
Leaf and stem-bark aqueous extracts of neem-Azadirachta indica (A), pawpaw-Carica papaya and bitter leaf-Vernonia amygdalina (V) at 2.5, 5.0, 7.5 and 10% of the active ingredient were used in investigating their effectiveness in the control of web blight of cowpea, incited by Rhizoctonia solani. In vitro, all plant extracts except those of pawpaw stem bark and its leaf at 2.5% concentration, significantly reduced mycelial growth of the fungus compared with the control. In vivo, both leaf and stem-bark extracts of A and only the leaf extract of V reduced the incidence of the pathogen by 35-73%. Combinations of AC and CV (1: v/v) significantly enhanced the anti-fungal properties of pawpaw extracts than when its extracts alone were used on the pathogen.
Keywords: Vignia unguiculata, web blight and plant extracts

Introduction
Cowpea, *Vigna unguiculata* (L.) Walp., is an important food for both human beings and livestock in Nigeria. The dry seeds may be eaten in its form or milled into flour, which is then used in several ways. Similarly, the fresh seeds and immature pods are eaten as vegetables. The young shoots and leaves are eaten as spinach and they are widely used as potherbs in Tropical Africa (Onwueme and Singh, 1999). However, many diseases threaten its production. One of the most destructive fungal diseases of cowpea is web blight caused by *Rhizoctonia solani* Kuhn. Synthetic fungicides have been used to control this disease (Oyekan, 1979), but being a soil-borne disease, its elimination in the soil after establishment by chemicals is costly and sometimes hazardous. Besides, the fungicides are gradually becoming ineffective due to the development of new physiological races of pathogens (Wellman, 1977). Thus, the search for more acceptable alternative means of control has been stimulated in the use of plant products with fungicidal properties, which are less phytotoxic and biodegradable (Singh and Singh, 1980; Tewari and Nayak, 1991; Gerard et al., 1994). More higher plants and their constituents which have shown success in controlling certain other diseases but which have not been tested on *R. solani* elsewhere because of their non-availability in those areas need to be investigated (Adebitan, 1997; Obagwu et al., 1997; Olufolaji, 1999; Owolade and Osinkalu, 1999). This study was undertaken, therefore, to screen extracts from the leaves and bark of neem-*Azadirachta indica* Juss, pawpaw-*Carica papaya* and bitter leaf-*Vernonia amygdalina* to control web blight of cowpea.

Materials and Methods
Preparation of plant extracts
For the preparation of plant extracts, fresh leaves and stem bark of *A. indica*, *C. papaya* and *V. amygdalina* were collected, and washed thoroughly under running tap water and sterile distilled water. Hot water extraction method of Kurucheve and Padmavathi (1997) was used. The plant materials (leaves and stem-bark) were separately chopped into the required amount of water (1:1 w/v) using a grinder. The contents were emptied into conical flasks placed inside water bath, which was heated at 80°C for 10minutes. Each suspension was vigorously agitated for 24 hours using the orbit shaker to effect dissolution.

Laboratory study
To prepare plant extracts; potato dextrose agar-lactic acid amended media (PDAL), all of each aqueous plant extract (prepared as described above) of 1.25, 2.5. 3.75 and 5.0 mL was separately mixed with 48.75, 47.50, 46.25 and 45.0 mL of molten PDAL which had earlier been autoclaved at 1.1 kg.cm^3 at 121°C for 15 minutes and cooled to about 50°C to get the final concentration of 2.5, 5.0 7.5 and 10% of the extracts in the media. Three drops of 10% lactic acid were added to prevent bacterial contamination. Each of the media was then poured into four petri dishes at the rate of about 20 mL per dish and allowed to cool. Benlate, a standard fungicide with formulated concentration of 3.3 g/200 mL of water was used to compare the efficiency of the test materials. Un-amended (i.e. normal PDAL) plates served as the check treatment. With the aid of sterile needle, each petri dish was inoculated in the centre with 5 mm disc mycelia of the fungus cu from the edge of a 7-day old fungal colony. The plates were incubated at 28±2°C for 9 days after which records of colony diameter was taken. Colony diameter was determined by taking the difference between the diameter of the initial mycelial inoculum and that of the cumulative radial growth measured using a pair of compass along two lines drawn perpendicularly to each other on the bottom of each plate. The mean of the two lines was recorded for each colony. The experiment was repeated twice and all treatments in each case were laid out in a completely randomised design.

Screen house studies
One hundred and four perforated plastic pots (1.2 dm2) were sown on each pot filled with sterilised sandy clayey soil. Four seeds of cowpea (cv ART 91-2) susceptible to web blight) were kept on the screenhouse bench and watered daily with tap water. Seedlings were thinned to three at 7 days. At 21 days after emergence, all seedlings were directly inoculated with sclerotia produced from the pure culture of *R. solani* by injecting the stems of the disease-free potted plants at the area between the cotyledons and first leaves with a hypodermic syringe. The inoculated plants were removed from the top of the bench. The aqueous suspension of each plant extract was sprayed at the various rates to run-off after h of inoculation against the disease. Benlate was also sprayed and a control was set up with only pathogen inoculation. All treatments and the control were replicated four times and the experiment was repeated twice. Observation on disease incidence and disease severity were recorded on the 12th day after spraying the extracts. Disease incidence was calculated from the number of infected plants in the plant population. The severity of web blight on the seedlings was scored on a 0-5 scale in which 0= no visible *Rhizoctonia* web blight infection, 1= greater than 0% but less than 12.9% of the plant foliage affected, 2= 13.0- 24.9%, 3= 25.0-49.9%, 4= 50.0-74.9% and 5= 75-100% of plant foliage affected.

Effect of plant extracts combination
The complementary effect of the fungi-toxicity of the combination of the extract of the three plants on *R. solani* at 2.5 and 10% concentrations were also tested in separate experiments. The extracts were combined together in pairs on 1:1 v/v basis both in the laboratory and in screenhouse. Experimental set-up was as earlier described for each case.

Statistical analysis
Data collected from the experiments were analysed by analysis of variance (ANOVA) and means were separated using Duncan's New Multiple Range Test.

Results and Discussion

Compared to the check treatment, *in vitro*, all the plant extracts significantly (P <0.05) reduced the mycelial growth of *R. solani* at the various concentrations tested except that of *C. papaya* at 2.5% (Table 1). Reduction in growth obtained from the use of the extracts over control ranges from 46.5 to 79.1%. Extracts of *V. amygdalina* were most effective. The least mean mycelial growth was recorded in limiting the growth of the fungus than the leaf extracts. However, there was no significant difference between these extracts obtained from the two different plant parts. This observation probably indicates that extracts from both plant parts possess the same amount of toxic principles for their fungicidal effects. Generally, there was decrease in mycelial growth with increase in the concentrations of the extracts demonstrating the fact that the fungitoxic effect of the extracts was more fully expressed at higher concentrations. This is in conformity with earlier reports (Basak and Chacraborty, 1988). Similarly, in the screen house, evaluation of the plant extracts showed the same pattern of results as those earlier obtained in the laboratory. Disease incidence and severity of web blight of cowpea was significantly affected by type of plant extracts and concentrations used. A percent reduction ranging between 35 to 73% for disease incidence and 29-60% for disease severity was recorded, as a result of using extracts of *V. amygdalina* and *A. indica* at various concentrations. With increased concentration of plant extracts, there was corresponding significant (P <0.05) decrease in the incidence and severity of the disease, although none of the extracts at the various concentrations favourably compared with Benlate in reducing web blight (Tables 2 and 3). These findings reveal the anti-fungal properties of extract of the plant parts used in the control of web blight disease of cowpea in this study. This corroborates the findings of other workers who worked on *R. solani* using other plant species (Singh and Singh, 1980; Tewari and Nayak, 1991; Gerard et al., 1994). As a result of pairing the extracts of the three plants, there were more reductions in mycelial growth than when each of the extracts was used alone at the two concentrations tested (Table 4). For instance, it was previously observed in the present study that there was no significant difference in mycelial growth due to the use of *C. papaya* extracts at 2.5% concentration. However, because of the combination, with the extracts of either of the plants, there was significant reduction in mycelial growth. This observation was further supported by the additive effect of AV (when used at a higher concentration of 10%) which resulted in a similar reduction comparable to Benlate. Screenhouse studies also revealed similar results as shown in Table 5. This may thus suggest that there was synergism, which might have enhanced the anti-fungal activities of the individual plant extracts.

Table 1: Effect of plant extracts at various concentrations on radial growth of *R. solani*

	Radial growth (mm)			
Treatment	**2.5%**	**5.0%**	**7.5%**	**10%**
A. indica				
Leaf	35.2^{a}	35.0^{bc}	31.9^{bc}	24.0^{bc}
Bark	38.4^{b}	37.6^{bc}	34.7^{bc}	29.4^{cd}
C. papaya				
Leaf	84.7^{c}	46.0c	40.0c	36.4^{cd}
Bark	86.0^{c}	46.3^{c}	42.8^{c}	39.2^{bd}
V. amygdalina				
Leaf	34.5^{b}	28.4^{b}	26.3^{b}	18.1^{b}
Bark	36.5^{b}	30.8^{b}	27.9^{b}	22.3^{b}
Benlate	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}
Control	86.5^{c}	86.5^{d}	86.5^{d}	86.5^{e}

[a]Values with the same letters in the same column are not significantly different at 5% level (DMRT)

Table 2: Effect of plant extracts at various concentrations on disease incidence of web blight on cowpea

	Radial growth (mm)			
Treatment	**2.5%**	**5.0%**	**7.5%**	**10%**
A. indica				
Leaf	48.4^{bc}	41.5^{b}	33.3^{b}	21.4^{b}
Bark	53.6^{c}	45.6^{b}	37.0^{b}	28.2^{b}
C. papaya				
Leaf	79.6^{d}	75.3^{c}	65.2^{c}	52.5^{c}
Bark	81.7^{d}	78.9^{c}	78.0^{c}	73.1^{d}
V. amygdalina				
Leaf	41.2^{b}	36.6^{b}	29.3^{b}	21.8^{b}
Bark	46.5^{b}	42.4^{b}	28.5^{b}	25.4^{b}
Benlate	10.3^{a}	10.3^{a}	10.3^{a}	10.3a
Control	82.0^{d}	82.0^{c}	82.0^{c}	82.0^{d}

[a]Values with the same letters in the same column are not significantly different at 5% level (DMRT)

Table 3: Effect of plant extracts at various concentrations on disease severity of web blight on cowpea

	Radial growth (mm)			
Treatment	**2.5%**	**5.0%**	**7.5%**	**10%**
A. indica				
Leaf	35.2b	2.4b	2.1b	1.8b
Bark	3.2c	2.7b	2.2b	1.9b
C. papaya				
Leaf	4.5d	4.1c	4.3c	3.1c
Bark	46d	4.2c	4.2c	4.3d
V. amygdalina				
Leaf	2.3b	21.b	1.9b	1.8b
Bark	2.4b	2.3b	2.0b	1.8b
Benlate	0.8a	0.8a	0.8a	0.8a
Control	4.6d	4.5c	4.4c	4.5d

[a]Values with the same letters in the same column are not significantly different at 5% level (DMRT)

Table 4: Effect of plant extract combination at two concentrations on radial growth of *R. solani*

	Radial growth (mm)	
Treatment combination	**2.5%**	**10%**
AC[a]	30.7c	13.5b
AV	17.2b	0.7a
CV	28.6c	9.4b
Benlate	0.0a	0.0a
Control	86.5d	86.5c

[a]A= *A. indica*; C= *C. papaya*; V= *V. amygdalina*. [b]Values with the same letters in the same column are not significantly different at 5% level (DMRT)

Table 5: Effect of plant extract combination at two concentrations on the incidence and severity of *R. solani* in cowpea

	2.5%		10%	
Treatment combination	**DI[a]**	**DS**	**DI**	**DS**
AC[b]	43.6[c]	2.3[b]	29.9[c]	1.8[b]
AV	28.0[b]	1.8[b]	14.7[b]	0.4[a]
CV	34.4[c]	2.0[b]	25.3[c]	1.7[b]
Benlate	0.0[a]	0.3[a]	0.0[a]	0.3[a]
Control	83.4[d]	4.5[c]	83.4[d]	4.5[c]

[a]DI= Disease incidence; DS= Disease severity.
[b]A= *A. indica*; C= *C. papaya*; V= *V. amygdalina*;
[c]Values with the same letters in the same column are not significantly different at 5% level (DMRT)

Conclusion

The plant products used in this study are locally available everywhere in Nigeria. Their potential as biocidal substances for the control of *R. solani* infecting cowpea has been demonstrated. With further field studies confirming their efficacy, especially at higher concentrations than used presently, their extracts could offer a practicable and environmentally friendly alternative to the use of synthetic fungicides, which are fraught with many limitations.

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Effect of Foliar Fertilizer on Productivity and Yield of Grain Amaranth (*Amarantus cruentus* L.) in Sudan Savannah, Nigeria

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Abstract
A field experiment was conducted during the 2010 rainy season at the Faculty of Agriculture, *Teaching and Research Farm, Bayero University, Kano, Nigeria (11⁰ 58'N, 8⁰25'E and 475 m above sea level), to determine the influence of Foliar fertilizer on the productivity of grain amaranth (Amaranthus cruentus L.). The treatments consisted of four levels of foliar fertilizer (0.0, 2.5, 5.0 and 7.5 kg BONUS NPKha^{-1}) which were replicated five times and laid out in a Randomized Complete Block Design (RCBD). Data was collected on; Plant height, Number of leaves, Leaf area, Leaf area index, Days to 50% anthesis, Panicle length, Number of lodged plants and Grain yield. The result showed that only number of leaves per plant of grain amaranth at 8 weeks after transplanting was significantly (P≥ 0.05) affected by the foliar fertilizer. The lack of response on other characters could be attributed to the high fertility of the soil at the experimental site. Application of 2.5 kg BONUS NPKha^{-1}foliar fertilizer gave the highest grain yield, even though it was statistically similar to other levels. The experiment could be conducted under different soil conditions to ascertain if there is significant contribution of the foliar fertilizer on the productivity of grain amaranth.*
Keywords; Grain amaranth, Foliar fertilizer and Grain Yield

Introduction
Grain amaranth also called *Amaranthus cruentus* L. is a nutritious crop and contains relatively high amounts of minerals and vitamins, which are needed for healthy body growth, sustenance and alleviation of problems of hunger and malnutrition mostly experienced amongst children in developing countries (Aphane *et. al.,* 2003). *Amaranthus cruentus* L. is a member of the family amaranthaceae and is widely cultivated in Nigeria (Omidiji, 1976). It was introduced several centuries ago in to tropical Africa from Central America by European explorers, in Africa it passed quickly from tribe to tribe probably as weed in millet, maize or sorghum seed. *Amaranthus cruentus* is an erect annual herb which grows to a height of 1-2 m and often with a branching habit (Grubben and Vansloten, 1981). It has a growing period of 5 to 6 weeks thus making it to have an advantage to the rural and peri-urban farmers in Nigeria to keep cultivating it two or more times on the same piece of land in a year (Adewole and Igberaese, 2011). According to National Research Council (NRC, 1984), *A. cruentus* is probably the most adaptable of all the amaranth species. For seeds to germinate and establish roots amaranth require well drained soil and for optimum yield, it requires fertile well drained soils with a loose structure and high level of moisture throughout the growing season (Tindall, 1983). Foliar fertilizer is any fertilizing substance applied in a liquid form on the plants shoot. Certain of the fertilizing nutrients soluble in water may be applied directly on the aerial portion of the plants. When problems of soil fixation exist, foliar application constitutes the most effective means of fertilizer placement (Tisdale *et al*., 1966). So far, the most important use of foliar sprays has been in the application of micronutrients. The greatest difficulty in supplying N, P and K, in foliar spray is in the application of adequate amounts without severely burning the leaves and without unduly large volume of solution or number of spraying operations. However, foliar sprays are an excellent supplement to soil application of the major nutrients (Tisdale *et al*., 1966). Currently, there is a dearth of information on the growth performance, yield and nutritional quality of *A. cruentus* after repeated application of foliar fertilizer. While it is true that the major elements N, P

and K are more economically supplied in solid form, some experts believed that it was only the quantity of these that counted (Anon, 2010). Foliar spraying produces more rapid absorption of Nitrogen than soil application. Much more needs to be learnt about foliar application and its value in supplementing standard soil fertility programmes (Tisdale *et al*., 1966). Therefore, this research is aimed at determining the productivity and yield of grain amaranth (*Amarantus cruentus* L.), as influenced by foliar fertilizer in the Sudan savannah ecological zone of Nigeria.

Materials and Methods

A field experiment was conducted during the 2010 rainy season at the Faculty of Agriculture, Teaching and Research Farm, Bayero University, Kano, Nigeria (11^0 58'N, $8^0$25'E and 475 m above sea level) in the Northern Sudan Savannah ecological zone of Nigeria. The site has mean annual rainfall and temperature of about 800 mm and 31^0C, respectively (KNARDA, 2001). The treatments consisted of four levels of foliar fertilizer (0.0, 2.5, 5.0 and 7.5 kgha^{-1}) of BONUS NPK 20:20:20. They were laid out in a Randomized Complete Block Design (RCBD) and replicated five times. The field was cleared, ploughed, harrowed and ridged 75 cm apart using tractor and marked into plots and replicates. Alley ways of 1.0 m between plots and two ridges between replications were used. The field was marked into five rows of three meters length with two middle rows as the net plot and the third middle row for sampling. The gross plot size was 11.25 m^2. Seeds of grain amaranth (NHAR 493-1) were obtained from National Horticultural Research Institute (NIHORT) Progeny substation, Bagauda, Kano, Nigeria and sown in a well prepared nursery bed of 1.5 m x 5 m in drills of 10 cm apart. They were mixed with fine sand before planting. Watering was done regularly before the establishment of rainfall. Seedlings of 7-10 cm length with 4-6 leaves were removed from the nursery and transplanted three weeks after sowing (WAS) early in the morning at a spacing of 25 cm on ridges spaced 75 cm apart. Appropriate measures were used to control pests and diseases. Inorganic fertilizer was applied at the rate of 50 kg N ha^{-1}, 30 kg P_2O_5 ha^{-1} and 30 kg K_2O ha^{-1} (NPK 15:15:15) by side dressing at two weeks after transplanting (WAT). Urea was later used to balance the remaining Nitrogen at 5 WAT together with the foliar fertilizer (see product analysis in Table 4) as per treatment level by spraying the foliar fertilizer on the leaves using a mini sprayer (Hand held) following manufacturers guide. Harvesting was done by cutting the heads when the grain appear to be physiologically matured (>110 days after sowing) and dried before threshing. The dried heads were placed in a bag (Woven sack) and beaten (Plailing) with a stick which loosens the grain and separated them from the panicle and later winnowed gently to obtain clean grains according to the plots, weighed and bagged separately. Data were collected from five randomly sampled plants at 8 and 10 WAT weeks after the foliar fertilizer was applied on the following parameters; Plant height (cm), measured from the ground level to the terminal bud using a measuring tape; Number of leaves per plant, recorded by counting the number of fully opened/expanded leaves on the sampled Plants; Leaf area (cm^2), determined by measuring the length and width of the sampled plants and their product fixed into the equation: $LA = -0.854 + (LW) * 8.744$, where, L= length and W= width (Kintomo and Ojo, 1997); leaf area index (LAI) was determined from the total leaf are obtained per ground cover per plant as described by Watson (1952), thus;

$$\mathrm{LA} = \frac{\text{Total leaf area per plant}}{Areaofgroundcoverperplant}$$

Panicle length (cm), obtained by measuring the length of the panicle from the base to its peak/apex using a measuring tape at the time of harvest; Days to 50% flowering/anthesis recorded when 50% of the plants in each plot commenced flowering; grain yield per hectare (kg ha^{-1}), determined after harvesting, drying, threshing and winnowing the amaranth. The grains obtained were weighed using a scale and the value obtained fixed into the equation:

$$\text{Total grain yield} = \frac{10{,}000\ \mathrm{m}^2}{Planta\ rea} * Yield\ per\ plant.$$

Data collected were subjected to analysis of variance (ANOVA) to test for significant differences of the treatment means using SAS software (SAS Institute, 1993) Significantly different means were separated Using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

The effect of foliar fertilizer on plant height (cm), number of leaves, leaf area and leaf area index of grain amaranth at 8 and 10 WAT is presented in Table 2. The different levels of the foliar fertilizer had no significant effect on the plant height. This could be attributed to the fact that the soil of the experimental site is fertile enough and had satisfied the crops requirement, also the soil is rich in nitrogen as it has been cultivated the previous year with cowpea and the haulms were not removed, as such they serve as green manure (Table 1). Brandy, (1999) observed that foliar fertilizer assist plants in absorbing other nutrients and corrects nutritional imbalances when there is deficiency. Significant differences were observed on number of leaves of grain amaranth at 8 and 10 WAT, were 0.0 and 2.5 kg ha^{-1} recorded more number of leaves (49.7 and 49.0, respectively). The decrease in number of leaves at higher doses could be attributed to toxicity of the fertilizer. The different levels of the foliar fertilizer also had no significant effect on leaf area and leaf area index per plant of grain amaranth; this may also be as a result of the soil being fertile enough to supply the needed nutrients to the crop. The effect of foliar fertilizer on days to 50% anthesis, panicle length (cm) at harvest, number of lodged plants and grain yield per hectare (kg ha^{-1}) at harvest is presented in Table 3. Application of foliar fertilizer had no significant effect on the above mentioned parameters. It was observed that, the number of lodged plants was more at the control. This may be attributed to the fact that the plants produced longer panicles and as such more prone to lodging. Application of foliar fertilizer had no significant effect on grain yield of grain amaranth in this experiment. It may be as result of the soil having enough nutrients in addition to the NPK applied initially to supply the needed nutrients for the crop. Manga, (2001) reported that application of NPK in the ratio 50:30:30 respectively, were observed to be optimum for growth and yield of grain amaranth in the savannah ecological zone of Nigeria. In this experiment, application of 2.5 kg $ha^{-1}$of the foliar fertilizer was observed to produce the highest yield even though it was statistically similar to all other levels.

Conclusion

From the results obtained, application of foliar fertilizer had increased the number of leaves to a certain limit beyond which further application had no significant effect. Application of 2.5 kg ha^{-1} of the foliar fertilizer was observed to give the best yield even though it was statistically similar to all other levels. The experiment could be conducted under different soil conditions with poor soils to ascertain whether there is any contribution of the foliar fertilizer on the productivity of grain amaranth.

Table 1: Physico chemical properties of the soil of the experimental site during the 2010 rainy season

Soil properties	Collection Depth (0 – 30 cm)
Physicalcomposition	
Clay (%)	16.0
Silt (%)	10.2
Sand (%)	73.8
Textural class	Sandy loam
Chemical composition	
pH in water	5.03
pH in $CaCl_2$	6.71
Organic carbon (g/kg)	1.1
Total nitrogen (g/kg)	0.88
Available P (ppm)	13.64

Source; Analysed at the laboratory of Department of Soil Science, Bayero University, Kano

Table 2: Effect of foliar fertilizer on plant height (cm), Number of leaves, leaf area (cm^2) and leaf area index (LAI) of grain amaranth at BUK new site during the 2010 rainy season

Treatments	Weeks after transplanting							
	PltHt		NLV		LA		LAI	
	8	10	8	10	8	10	8	10
BONUS NPK								
0.0	141.0	149.7	49.7a	51.2	3040.2	3116.2	1.62	1.66
2.5	138.1	150.7	49.0a	51.5	3074.4	3190.4	1.62	1.70
5.0	136.6	148.4	43.1b	45.3	2971.1	3122.9	1.58	1.67
7.5	138.1	151.4	44.5b	48.8	2716.4	2852.7	1.45	1.52
SE±	3.20	3.24	1.25	1.82	106.16	101.67	0.06	0.05

NB: Means with the same letter are not significantly different at 5% level of probability using DMRT. PltHt = Plant height, NLV = Number of Leaves, LA = Leaf area and LAI = Leaf area index

Table 3: Effect of foliar fertilizer on days to 50% anthesis, panicle length (cm), number of lodged plants and Grain yield per hectare of grain amaranth in BUK new site during the 2010 rainy season

Treatments	D 50% A	PL (cm)	NLP	GY (kg ha^{-1})
BONUS NPK				
0.0	62.8	60.5	10.0	970.0
2.5	64.8	58.7	9.8	1294.0
5.0	64.6	59.0	7.8	956.0
7.5	63.4	56.7	8.2	966.5
SE±	0.75	2.53	1.35	87.85

NB: Means with the same letter are not significantly different at 5% level of probability using DMRT. D 50% A= Days to 50% anthesis, PL = Panicle length, NLP =Number of lodged Plants and GY =Grain yield per hectare

Table 4: Product analysis of the foliar fertilizer (BONUS NPK)

Component	Amount
Total Nitrogen	20%
Nitrate-nitrogen ($N\text{-}NO_3$)	6.0%
Ammonical nitrogen ($N\text{-}NH_4$)	4.0%
Ureic nitrogen ($N\text{-}NH_2$)	10%
Phosphorus (P_2O_5 soluble in water and in neutral ammonium-citrate solution	20%
Pottasium (K_2O)	20%
Iron (Fe)+	1000 ppm
Manganese (Mn)+	500 ppm
Boron (B)	200 ppm
Zinc (Zn)+	150 ppm
Cupper (Cu)	110 ppm
Molybdenum (Mo)	70 ppm

*EDTA – cheleted, chloride free. Source; Dizengoff W. A. (Nigeria) Ltd

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Effects of X-ray on Germination and Early Growth Parameters of *Treculia africana* Decne *Parkia biglobosa* (Jaccq) and *Pentaclethra macropylla* Benth

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Abstract
The use of physical mutagens such as gamma ray and x-rays is one of the ways through which genetic makeup of a plant can be altered. The seed of T. africana, P. macrophylla and P. biglobosa were exposed to ionizing radiation (x-rays) before sowing at different doses. The doses used for the study were taken from dosimetry test carried out. The effect of x-rays was observed on the germination and growth parameters of the seedlings. In T. africana 86.7% germination emerged from 8 MGy, 4 MGy produced 76.7% germination in P. biglobosa and 8 MGy in P. mecrophylla gave 86.6% germination. Some of growth parameters were influenced positively by the ionizing radiation among the tree species. Some characters were influenced negatively by some dose. It was concluded that x-rays can be used to generate high germination percent in forest fruit trees.Further exploration in using physical mutagen should be taken for the improvement of indigenous forest fruit trees.

Key words: Ionizing radiation, Treculia africana, Parkia biglobosa, Pentaclethra mecrophylla, germination and growth parameter

Introduction
The harvesting, utilization and marketing of fruit and nuts from indigenous trees have been central to the livelihoods of majority of rural communities throughout Africa (Akinnifesi *et al.,* 2004; Leakey *et al.,* 2005) and can make a difference during period of famine and food scarcity (Mithofer and Waibel, 2003). Wild harvesting of fruits from forests and semi-domesticated trees growing on-farm and homesteads can substantially boost rural income and employment opportunities in Africa (Leakey *et al.,* 2005; Ruiz-Perez *et al.,* 2004). Indigenous fruits form a staple food during the hunger periods in the agricultural cycle. A study in Malawi, Mozambique and Zambia reveal that 26 – 50 % of rural households relied on indigenous fruits as a coping strategy during critical seasonal hunger period which usually last for three to four months per year (Akinnifesi *et al.,* 2004). *Treculia africana, Parkia biglobosa,* and *Pentaclethra macrophylla;* are indigenous fruit trees that are cheap source of food, medicine, fodder and cash (Maghembe *et al.,* 1994). There has been limited interest in their conservation, propagation and genetic improvement. Their domestication is hampered by a number of factors: they are perceived as growing slower and taking longer to produce fruits as compared to agricultural and horticultural crops, they have a low ratio of edible to non-edible parts with seasonal availability and limited number of their species. The impact of ionizing radiation on plant growth is largely deleterious and at high doses, is lethal. Although at low doses growth stimulation may occur, the sensitivity of various plant species to different doses of ionizing radiation varies greatly (Sax, 1955). The behavior of numerous plant species under exposure to Gamma radiation have been extensively studied (Irfaq and Nawab, 2011). In comparison, studies on effect of x-rays are relatively limited. Nonetheless, x-rays irradiation was shown to induce biological modifications that affected plant growth, cellular mechanisms and metabolism functions (Younis *et al.,* 1962). Heavy doses of x-rays were shown to reduce seed viability, germination and growth in wheat and barley (*Hordeum vulgare*) (Froier and Gustafsson, 1941). Moreover, x-radiation can cause cytological changes and induce mutations (El Araqi *et al.,* 1997). In a recent study, Al-Enezi and Al-khayri (2012) have shown that x-irradiation induced changes in the content of DNA, photosynthetic pigments and ions in date palm seedling. Narah and Jameel (2012) have suggested that irradiation is a powerful tool for genetic improvement of agricultural plant. Keeping in view of some positive effect of

irradiation, it is in order to evaluate impacts of x-ray on *T. africana, P. biglobosa,* and *P. macrophylla* seeds. Further, it is also assumed that the understanding of x-ray responses on seed of forest trees could provide insight for strategic genetic modification in general and more specifically in economically valuable seedlings under breeding programs.

Materials and Methods

Study Area

The experiment was conducted in an experimental nursery at Forestry Research Institute of Nigeria, Eastern Research Station, Okwuta Isieke Umuahia North in Abia State. This FRIN outstation is located on the low land rainforest of Nigeria. It lies on the latitude 05 ^{0}29`N, and longitude 07 $^0$33`E with average rainfall of 2238 mm per annum, which is distributed over eight months rainy season period (March – October) with bimodal peak in June /July and long dry season occurring between Novembers to February. The minimum and maximum temperature is 23 ^{0}C and 32 ^{0}C respectively and the relative humidity is 60-80 % (Source: Metrological Section of National Root Crops Research Institute (NRCRI) Umudike Nigeria, 2005).

Fruit collection and seed extraction

Mature fruits of *Treculia africana* were procured from mother tree at Okwuta Village in Umuahia North, Abia State. The seeds were extracted from the fruits following the method of Ugwu and Oranye (2006). Fruits of *Pentaclethra macrophylla* were procured at Forest Estate of Forestry Research Institute of Nigeria, ERS Umuahia. The fruits were broke longitudinally for seeds extraction. Mature fruits of *Parkia biglobosa* were also procured from mother tree at Asunara village, Ibarapa area in Oyo State, Nigeria. The fruits were depulped for the seed extraction. The seeds collected were air dried for three days. In order to determine suitable dose for the selected tree species, dosimetry test was carried out for the seeds of *T. africana, P. biglobosa* and *P. macrophylla* at Radiology Department, FMC Umuahia.

Seed treatment/seed bombardment

Irradiation of *T. africana, P. biglobosa* and *P. macrophylla* seeds was performed using X-ray source in ambient condition at Radiology Department Federal Medical Centre Umuahia. The dose used was from the result of dosimetry test carried out. Thirty- five (35) seeds of *T. africana* were exposed to 6 MGy. Another Thirty- five (35) seeds were exposed to 8 MGy exposure. Thirty- five (35) seeds of *T. africana* were used for control. For *P. biglobosa,* thirty- six (36) seeds were exposed to 2 MGy. Another thirty- six (36) were exposed to 4 MGy. Thirty- six (36) seeds were also used for control. For the species *P. macrophylla,* twenty- five (25) seeds were exposed to 4 MGy. Another twenty- five (25) seeds were exposed to 8 MGy. Twenty- five (25) seeds of *P. macrophylla* were also used for control (un-irradiated seeds).

Sowing of irradiated seeds

Immediately after the irradiation of the samples, the seeds were sowed into germination boxes containing sharp river sand. After two weeks of germination in each selected plant species, the seedlings were pricked into prepared poly pots containing loamy soil from the same source.

Recording of germinating seeds

Data recording on germination started when shoot tip was noticed in each selected three species. This was carried out every day for the period of two weeks.

Germination percentage was calculated after two weeks of germination in each plant species using this equation;

$$\text{Percentage germination} = \frac{\text{number of germinated seeds after n}^{\text{th}}\text{ day}}{\text{total number of seeds kept for germination}} \times 100$$

Germination rate was also calculated using the method of Djavnshir and Pourbeik (1976)

Design of the experiment

The design of the experiment is a complete randomized design (CRD) with two treatments. Treatments were replicated 11 times for *T. africana,* and 9 times for *P. biglobosa* and 8 times for *P. macrophylla.* CRD is used because the only source of variability apart from experimental error is the treatment applied. The analysis is based on the linear model

Y_{ij} = μ+ Ti + Eij (Wahua, 1999)

Where

Y_{ij} = value of any observation

μ = population mean common to all treatment

T_i = treatment effect

E_{ij} = random error

Recording of growth parameters
Growth parameters recorded were plant height, number of leaves, leaf area and stem diameter. Plant height was measured from the soil level to the terminal leaf using a meter rule. Stem diameter was obtained by using the venire caliper. Leaf area was determined by tracing the number of squares covered by the leaf on graph sheet. Each square equals 1 cm^2. Number of leaves was by visual counting of the leaves as the plants grew. The recording of these growth parameters were taken every fortnight.

Results and Discussion

Germination percentage of irradiated seeds of selected tree species
T. africana seed germinated 14 days after sowing in control and irradiated sample with 8 MGy. The irradiated seed with 8 MGy and control gave 86.7 % germination, while 6 MGy dose gave 76.6 % germination. Germination occurred in *P. biglobosa* 7 days after sowing. The irradiated seeds with 4 MGy gave 76.7 % germination. The seeds exposed to 2 MGy gave 66.7 % germination while the least germination percentage 56.7 % was emanated from un-irradiated seeds. In *P. macrophylla,* radical tip emerged 19 days after sowing in irradiated seeds with 8 MGy, produced highest germination percentage of 86.6 %. This followed by irradiated seed with 4 MGy which gave 73.3 %. The least germination percentage was recorded in control, un-irradiated seeds of *P. macrophylla* with 66.6%.

Results of growth parameters of *T. africana*
Height growth (cm)
The shoot height of *T. africana* treated with 6 MGy was 14.1cm, treatment 8 MGy gave shoot height of 12 cm and control height was 13.1cm (Table1). Treatment significance calculated showed significant difference ($p < 0.05$) in the shoot height of the seedlings due to differences in dose applied to the seeds.
Stem diameter growth (cm)
The mean stem diameter ranged from 0.181 cm to 0.198 cm (Table 1). The highest mean diameter (0.198 cm) was recorded for seeds treated with 8 MGy. This was followed by the seeds bombarded with 6 MGy (0.185 cm) while the control had the least mean stem diameter growth of 0.181 cm. Analysis of variance showed significant difference ($p < 0.05$) in the diameter growth of the seedlings.
Leaf area (cm^2)
The largest mean leaf area was recorded in seedling was recorded in seedling of control (14.5 cm^2). This was followed by the leaf area seedlings growing from the seeds bombarded with 6 MGy (13.5 cm^2) while the smallest leaf area (13.4 cm^2) was recorded for the seedlings produced from seeds treated with 8 MGy (Table.1). Analysis of variance shows that doses were not significantly ($p < 0.05$) influenced leaf expansion of the seedlings.
Leaf production
Effect of x-ray doses used (6 and 8 MGy) for seeds bombardment were influenced leaf production of the seedlings, that is, there were significant ($p < 0.05$) effects of the rays on leaf production of *T. africana.* The number of leaves produced varied between 3.30 and 3.61, with the highest mean leaf production (3.61) recorded from the control. This was followed by seeds treated with 6 MGy, (3.44) while the least leaf production (3.30) was recorded for 8 MGy dose (Table .1).

Table 1: Treatment means and standard error for *T. africana* growth parameters

Parameters	6 MGy	8 MGy	Control
Seedling height mean ± std. error	14.1 ± 0.5700	12.0 ± 0.4400	13.1 ± 0.54300
Seedling diameter mean ± std. error	0.185 ± 0.0731	0.198 ± 0.0400	0.181 ± 0.0766
Seedling leaf area mean ± std. error	13.5 ± 1.0400	13.4 ±1.1800	14.5 ± 1.2600
Seedling number of leaf mean ± std. error	3.44 ± 0.1920	3.30 ±0.1820	3.61 ± 0.2160

Results of growth parameters of *P. biglobosa*
Height growth (cm)
Result in (Table 2) shows that the shoot mean height of *P. biglobosa* seedlings produced from seeds exposed to x-ray range between 20.3 and 22.3 cm. The highest mean height was observed in 8 MGy with mean value of 22.3 cm. The mean height value for the seedling raised form seeds

exposed to 2 gray was 20.3 cm. While control seedlings gave 20.7 cm. Analysis of variance showed significant ($p < 0.01$) effect on the shoot growth.

Stem diameter growth (cm)

The mean stem diameter growth ranged from 0.161 cm to 0.167 cm (Table 2). The highest mean diameter (0.167 cm) was recorded for seedlings germinated from seed treated with 4 MGy exposures. The same value was also recorded in control. While 2 MGy exposure produced seedlings with mean diameter of 0.161 cm. Analysis of variance showed that x-ray treatment had no significant ($p < 0.05$) effect on mean diameter growth of the seedlings.

Leaf area (cm^2)

Effect of x-ray dose significantly influenced leaf expansion of the seedlings. There was significant effect ($p < 0.05$) of x-ray on leaf area increment. The treatment, 4 MGy gave mean leaf area of 16.6 cm^2. and 2 MGy gave mean area of 12.0 cm^2 while the control produced leaf area mean of 12.8 cm^2 (Table2).

Leaf production

The number of leaf production in both 2 MGy and 4 MGy seedlings ranged from 3.37 to 3.59. In control the mean leaf production was 3.63 (Table 4.1.9). X-ray treatment on leaf production of *P. biglobosa* was significant ($p < 0.05$) from the analysis of variance calculated.

Table2 Treatment means and standard error for *P. biglobosa* growth parameters

	2 MGy	4 MGy	Control
Seedling height mean ± std. error	20.3 ± 0.992	22.3 ± 944	20.7 ± 0.864
Seedling diameter mean ± std. error	0.161 ± 0.0043	0.167 ± 0.0490	0.167 ± 0.0049
Seedling leaf area mean ± std. error	12.0 ± 0.996	16.6 ± 1.38	12.8 ± 0.832
Seedling Number of leaf mean ± std. error	3.37 ± 0.195	3.59 ± 0.170	3.63 ± 0.168

Results of growth parameters of *P. macrophylla*

Height growth (cm)

From Table 3, the mean height for the rays applied were between 34.8 cm and 36.6 cm with highest mean obtained from seedlings produced by control (36.6 cm). While 4 MGy and 8 MGy gave mean height of 34.8 and 35.8 cm respectively. The height of *P. macrophylla* were not significantly ($P < 0.05$) influenced by 4 MGy and 8 MGy.

Diameter (cm)

The mean stem diameter growth ranged from 0.279 cm to 0.3 cm (Table 3). The highest mean diameter was recorded for seedlings germinated from treated seeds with 8 MGy. This was followed by the treated seeds with 4 MGy with 0.293 cm. While control gave mean diameter of 0.279 cm. Analysis of variance showed that the seeds exposed to x-rays at 4 and 8 MGy had significant influence ($P < 0.05$) on mean diameter growth.

Leaf area (cm^2)

Effect of x-rays influenced leaf expansion of the seedling raised from seeds treated with 4MGy and 8 MGy exposures. The highest mean (160 cm^2) leaf area was recorded in the seedlings produced by seeds of *P. macrophylla* treated with 4 MGy. The seeds treated with 8 MGy produced seedlings with the least leaf area (106 cm^2). While control seedlings produced leaf area of 140 cm^2 (Table 3). Effect of exposure to 4 and 8 MGy is significant ($p < 0.05$) from the analysis of variance calculated.

Leaf production

The number of leaves produced (Table3) varied between 3.12 and 3.67, with highest mean leaf production (3.67) recorded from the seedlings emerged from seeds exposed to 8 MGy. The seeds treated with 4 MGy exposure produced seedlings with leaf production of 3.12 while control entity produced mean leaf production of 3.45. There were significant differences ($p < 0.05$) in the leaf production of the seedlings raised from the seeds exposed to x- ray of 4 and 8 MGy.

Table 3: Treatment means and standard error for *P. macrophylla* growth parameters

	4 MGy	8 MGy	Control
Seedling height mean ± std. error	34.8 ± 1.59	35.8 ± 1.8	36.6 ± 1.13
Seedling diameter mean ± std. error	0.293 ± 0.00654	0.300 ± 0.00801	0.279 ± 0.00705
Seedling leaf area mean ± std. error	160 ± 7.8	106 ± 7.32	140 ± 55
Seedling number of leaf mean ± std. error	3.12 ± 0.157	3.67 ± 0.223	3.45 ± 0.184

The favorable germination which occurred *in T. africana*, *P. biglobosa*, and *P. macrophylla* was as a result of stimulation effect of x-rays. The effect of doses lead to acceleration in cell division rate as well as activation of auxins (Gunkel and sparrow, 1991). Variation (reduction and stimulation) in percentage germilation among the treated seeds might have due to the effect of mutagen on meristemic tissues of the seeds (Dhillon *el al.).*The results obtained among the treatments is line with the observation of Mozumder *et al.* 2004, Palashov and Gil 1997,that “the effect of ionizing radiation on any living organism depend on the amount and the rate of ionizing radiation which was absorbed, the type of ionizing radiation which was absorbed and the type and number of cells affected”. The results obtained in term of seed germination is also in accordance with the earlier reports of on *Acacia leucophloea, Albizia lebbeck,* and *Zizyphus mauritiana (*Akshatta *et al.2013).*The x-ray showed both positive and negative effects on the three tree species selected. That is, some doses influenced the plant characters positively while some did otherwise. The stunted effect on height growth experienced from some doses on the selected tree species may due to the negative effect of x-ray on the cells respossible for the shoot growth. Reduced shoot growth of the seedlings may be attributed to the increase in destruction on growth inhibitors, drop in the auxin level, or inhibition of auxin synthesis as reported by Roychodhury and Tah (2011) and Mostafa *et al*. (2014). The stunted growth may also due to physiological damage resulted in the alteration from normal to dwarf (El.Maksoud and El.Mahrouk, 1993). Joshi *et al*..(2011) explained the dwarfed growth to auxin destruction, changes in biochemical disturbance. The impact of x-ray investigated was varied within and among the species. Some dose produced stimulatory effect on stem diameter of the seedlings whereas some have retardation effect on diameter. The favourable effect produced by some doses on the selected species is in line with previous findings of Akashatta *et al*. (.2013) who observed stimulatory effect of ionizing radiation on the stem diameter of *Terminalia arjuna* using gamma rays. The reduction on diameter growth rendered by some of the dose might be attributed to the physiological damage to radial cell which responsible for the growth of diameter. On the leaf area, those doses which have better leaf area than control showed that they influenced the radial cells and other cells responsible for leaf elongation positively. The unfavourable effect on leaf production by some x-ray dose attributed to auxin synthesis as reported by Roychodhury and Tah (2011) and Mostafa *et al*. (2014).

Conclusion

Although small number of different doses was used for this study, some useful results were obtained most especially on the germination seeds of the selected tree species. It was concluded that x-rays can be used to generate high germination percent in forest fruit trees. The result of this study indicates that exposing forest tree seeds to x-rays before sowing would affect some morphorlogical characters of seedlings positively. It is therefore recommended that other source of physical mutagens should be tried on the selected species and other forest tree species for further exploration of this technology to be beneficial for growth strategies of indigenous fruit tree species.

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Effect of Sett-size and Fertilizer level on the Yield of White Yam (*Dioscorea rotundata*) in Umudike South-Eastern, Nigeria

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Abstract
Field experiments were conducted at eastern farm of National Root Crops Research Institute, (NRCRI), Umudike in 2016 and 2017. In both years, the experiment was laid out in a factorial trial and in a randomized complete block design (RCBD) with three replicates. Treatments comprised four levels of stake height (0, 1, 2 and 3m) and five levels of NPK (15:15:15) fertilizer (0, 200, 400, 600 and 800kg/ha). Result showed that fertilizer rate of 200kg/ha and stake height of 0m gave the highest number of tubers per plant (3.51) in 2017 while for tuber weight (kg), fertilizer rate of 0kg/ha and stake height of 2m gave the highest yield (0.680 kg) in 2016. For the tuber yield in (t/ha) in 2017, fertilizer rate of 200kg/ha by stake height of 0m gave the highest yield of (20.80t/ha). From this trial, we observe that farmers tend to go for 0kg/ha fertilizer by 2m stake height.

Keywords: Sett-size, fertilizer level, landrace and tuber yield

Introduction
Yam is one of the major stable foods for the people of Nigeria and to a large extent for people in West Africa (Nwankwo *et al,* 2005). There are six types of yam Species that are majorly cultivated in West Africa. They are the following: (*Dioscorea rotundata*), (*Dioscorea alata*), (*Dioscorea cayenensis*), (*Dioscorea dumentorum*), (*Dioscorea bulbifera*), (*Dioscorea esculentus*) (Okoli, 1986). The major aim of yam cultivation by farmers is not only for consumption but also, to generate income by selling it in the market. Not all yam tubers are acceptable in the market by the consumers (Nwankwo *et al,* 2005). Staking appears to perform functions such as increase in light interception of the leaf canopy and increase in ventilation around the leaves. Ventilation is particularly important in humid environments where high humidity in the canopy can increase the incidence of fungal leaf diseases, especially anthracnose. Staking also facilitates weeding, especially with thorny varieties (King and Risimeri, 1992).Scarce in much production area as land use intensifies. Obiazi (1995) reported that the average Nigerian farmer spends 60 person-days per ha in procuring and installing stakes. The dependence of yam genotypes on staking may relate to their strength of apical dominance and their tendency to branch. Those that are slow to initiate branches may develop best on tall stakes, where the vital early growth of the vine is uninterrupted. Those with less apical dominance and greater branchiness may be less assisted by staking. The system of staking depend on local conditions and available materials. A typical method is to provide one vertical stake per stand. Frequently, where stakes are less available, one stake may be provided for 2–6 stands. However, the staking height may depend on the species or cultivars, the planting materials and the environment. Fertilizer has necessitated fertilization which needs to be used rationally in order to avoid negative ecological impact and undesirable effects on the sustainability of agricultural production systems. In order to calculate the amount of fertilizer to be applied to crops, it is necessary to develop recommendation programmes. Irizarry *et al (*2015*)* reported that yams respond to high nutrient levels and fertilizer application under varying agronomic conditions. Consequently, they extract large quantities of nutrients from the soil. For example, a yam yield of 29 t/ha removed 133kg N, 10kg P and 85 kg K from the soil (Sobulo, 1972). Where there is need for fertilizer application, the recommendation is NPK (15:15:15) at 400-500 kg/ha applied at 8-12 WAP in bands on both sides of the ridges for single

row planting (Eke-Okoro *et al*. 2006), and double rows on each side of the ridge. However, Okpara *et aI, (*2014) have shown that fertilizer needs of yam may depend on the technology used to generate planting materials and plant population density, among other factors.

Materials and Methods

The trial was conducted at the eastern farm of (NRCRI) National Root Crops Research Institute, Umudike Nigeria in 2016 and 2017 cropping seasons. Only Yandu white yam cultivar was used. The stake height were 0,1,2 and 3m and the fertilizer levels were 0, 200, 400, 600 and 800kg/ha. The planting material was obtained from Yam Programme, NRCRI, Umudike, Abia State. The treatments were laid out in a Randomized Complete Block Design (RCBD) with three replications after land preparation. The ridge were spaced 1.0m apart and the cut tuber setts were planted on the crest of the ridge. The plot size was 4m x2m. Sett-size of 50g was planted at a spacing of 1m x0.3m in June 2016 and 2017 of each year. Pre-emergence herbicide (premextra) was applied immediately after ridging and this was complemented with manual weeding to ensure weed-free plots. Fertilizer NPK 15:15:15 was applied at different rate using side application method.

Data Collection: The following data were collected: Below the ground (harvest) trials: number of ware yam, number of seed yam, weight of ware yam, weight of seed yam, number of tuber per plot, weight of tuber per plot and tuber yield.

Data Analysis: Analysis of variance was performed on the data using (ANOVA).For the tuber yield analysis, treatment means was separated using (LSD) least significant difference at 5% probability level. The tuber yield was measured in tons per hectare.

Results and Discussion

The effect of NPK fertilizer and staking height on the number of tubers/plant of Yandu white yam cultivar in 2016 and 2017 are represented in Table 1(a) and (b). In 2016, Table 1(a), there was no significant (P>0.05) differences on fertilizer level of the white yam (Yandu) variety. However, fertilizer level of 600kg/ha and staking height of 1m gave the highest number of tubers per plant of 2.05 per 1000plants /ha. This was followed by 800kg/ha fertilizer level and staking height of 1m which gave 1.90 number of tubers per 1000per plant. There was no significant differences (P>0.05) on the interaction of NPK fertilizer 15:15:15 and staking height. Staking of 1m and fertilizer level at 600kg/ha gave the highest yield of 2.05 followed by 1m by 800kg?ha gave the highest number of tubers per plant of 1.90. There was no significant (P>0.05) on the interaction of NPK fertilizer level and staking height. In 2017, Table (1b), there was significant differences (P<0.05) of NPK fertilizer level on Yandu white yam cultivar. The NPK fertilizer of 200kg/ha and staking height of 0m gave the highest number of tubers per 1000 plants of 3.51 followed by fertilizer level of 400kg/ha and staking height of 1m which gave 1.56 number of tubers per plant. For staking, there was significant (p<0.05) difference. The stake height of 0m gave the highest number of tubers per 1000plants of 3.51 followed by 1m and 400kg/ha gave number of tubers of 156. However, there was significant (P<0.05) in the interaction on the fertilizer level and staking height. NPK fertilizer of 200kg/ha and staking height of 0m gave the highest number of tubers per 1000 tubers per plant which is 3.51. Effect of NPK fertilizer and staking height on the tuber weight (kg) of Yandu white yam cultivar is represented in Table 2(a) and (b). There was no significant (P>0.05) differences in the NPK fertilizer level in 2016 (Table 2a). For staking, there were significant (P<0.05) differences. The stake height of 2m and NPK level of 0kg/ha gave the highest tuber weight of 0.680kg followed by stake height of 3m and NPK level of 200kg/ha gave the tuber weight of 0.670g. For the interaction, there was no significant (P>0.05) differences. In 2017, table (2b), there was no significant differences in the NPK fertilizer level. Fertilizer level at the rate of 200kg/ha and 2m staking height gave the highest tuber weight of 0.526kg, followed by fertilizer level of 600kg/ha b and 0m staking height which gave 0.491kg.However, for staking, there were also, no significant (P>0.05) differences on the tuber weight. Stake height of 2m and fertilizer level at 200kg/ha gave the highest tuber weight of 0.526kg followed by staking height of 0m and fertilizer level of 600kg/ha gave the tuber weight of 0.491kg. For the interaction, there were significant (P<0.05) difference in both fertilizer level and staking height. The NPK fertilizer of 200kg/ha and 2m staking height gave the highest tuber weight of 0.526kg. Effect of NPK fertilizer and staking height on tuber yield in 2016 and 2017 are represented in Table 3(a) and (b). In 2016, Table 3(a), there was no significant (P>0.05) differences on NPK 15:15:15 level on tuber yield of Yandu white yam cultivar. However, the NPK fertilizer level at 400kg/ha and 0m staking height gave the highest tuber yield of 31.70t/ha. This was followed by NPK fertilizer level of 0kg/ha and 2m staking height which gave 29.60t/ha of the tuber yield. For the interaction, there was no significant (P>0.05) differences on the NPK fertilizer level and staking height. The NPK fertilizer rate at 400kg/ha and 0m staking gave the highest yield of 31.70t/ha. In 2017, table 3(b), there were no significant (P>0.05) differences in the NPK fertilizer level. The highest tuber yield in gotten from fertilizer level of 200kg/ha and 0m staking height which gave the yield of 20.80t/ha. This was followed by fertilizer level of 200kg/ha and staking height of 2m which gave the tuber yield of 18.33t/ha. For staking, there are significant (P<0.05) differences. The staking height of 0m gave the highest yield of 20.80t/ha followed by staking height of 2m which gave the yield of 18.33t/ha. For the interaction, there was no significant (P>0.05) differences on both the fertilizer level and staking height.

Conclusion

Based on this result obtained, fertilizer application at 200kg/ha and staking height of 0m gave the highest number of tubers per plant of (3.51). Also, for tuber weight, NPK 15:15:15 fertilizer of 0kg/ha and 2m staking gave the highest yield of (0.680kg) in 2016 and NPK 15:15:15 fertilizer of 200kg/ha and 2m staking gave the highest yield of (05260kg) in 2017. Also, for the tuber yield, NPK 15:15:15 fertilizer of 200kg/ha and staking height of 0m gave the highest yield of (20.80 t/ha). Therefore, staking height of 0m and NPK 15:15:15 fertilizer level of 200kg/ha could be recommended for the production of Yandu white yam cultivar.

Table 1(a): Effect of NPK fertilizer and staking height on the number of tubers/plant of Yandu white yam cultivar in 2016

	Staking height(m)				
NPK level(kg/ha)	**0**	**1**	**2**	**3**	**Mean**
0	1.48	1.51	1.30	1.56	1.46
200	1.58	1.46	1.72	1.19	1.49
400	1.77	1.60	1.69	1.62	1.67
600	1.87	2.05	1.36	1.55	1.71
800	1.59	1.90	1.40	1.72	1.65
Mean	1.66	1.70	1.49	1.53	

Table 1(b): Effect of NPK fertilizer and staking height on the number of tubers/plant of Yandu white yam cultivar in 2017

	Staking height (m)				
NPK level(kg/ha)	**0**	**1**	**2**	**3**	**Mean**
0	1.43	1.14	1.33	1.30	1.30
200	3.51	1.20	1.10	1.21	1.75
400	1.30	1.56	1.13	1.38	1.34
600	0.86	1.41	1.17	1.13	1.14
800	1.23	1.35	1.43	1.22	1.31
Ean	1.67	1.33	1.23	1.25	

		2016	2017
LSD($_{0.05}$) for NPK (F) means	=	NS	0.43
LSD($_{0.05}$) for Staking (S) means	=	NS	0.38
LSD($_{0.05}$) for F x S means	=	NS	0.86

Table 2(a): Effect of NPK fertilizer and staking height on the tuber weight (kg) of Yandu white yam cultivar in 2016

	Staking height (m)				
NPK level(kg/ha)	**0**	**1**	**2**	**3**	**Mean**
0	0.240	0.433	0.680	0.573	0.482
200	0.310	0.393	0.397	0.670	0.443
400	0.467	0.497	0.387	0.413	0.441
600	0.387	0.180	0.647	0.480	0.423
800	0.340	0.363	0.410	0.420	0.383
Mean	0.349	3.373	0.504	0.511	

Table 2(b): Effect of NPK fertilizer and staking height on the tuber weight (kg) of Yandu white yam cultivar in 2017

	Staking height (m)				
NPK level(kg/ha)	**0**	**1**	**2**	**3**	**Mean**
0	0.286	0.381	0.146	0.208	0.246
200	0.193	0.246	0.526	0.185	0.288
400	0.369	0.226	0.202	0.233	0.248
600	0.492	0.188	0.162	0.365	0.301
800	0.334	0.190	0.290	0.213	0.257
Mean	0.335	0.247	0.265	0.241	

		2016	2017
LSD(0.05) for NPK (F) means	=	NS	NS
LSD(0.05) for Staking (S) means	=	0.157	NS
LSD(0.05) for F x S means	=	NS	0.236

Table 3(a): Effect of NPK fertilizer and staking height on tuber yield (t/ha) of Yandu white yam cultivar in 2016.

	Staking height (m)				
NPK level(kg/ha)	**0**	**1**	**2**	**3**	**Mean**
0	11.20	20.50	29.60	28.10	22.40
200	15.80	19.30	22.90	27.10	21.40
400	31.70	27.20	21.00	20.80	25.20
600	22.30	10.40	27.80	23.00	20.90
800	18.70	21.40	19.20	23.90	20.80
Mean	19.90	19.80	24.10	24.60	

Table 3(b): Effect of NPK fertilizer and staking height on tuber yield (t/ha) of Yandu white yam cultivar in 2017

	Staking height (m)				
NPK level(kg/ha)	**0**	**1**	**2**	**3**	**Mean**
0	13.61	11.26	6.27	9.10	10.06
200	20.80	9.92	18.33	7.57	14.16
400	14.82	11.90	7.55	11.28	11.38
600	13.37	9.12	6.34	13.55	10.60
800	13.07	7.65	14.09	8.72	10.88
Mean	15.14	9.97	10.52	10.04	

		2016	2017
LSD(0.05) for NPK (F) means	=	NS	NS
LSD(0.05) for Staking (S) means	=	NS	4.68
LSD(0.05) for F x S means	=	NS	NS

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Effect of Sett-size and Fertilizer level on the Yield of White Yam (Dioscorea rotundata) in Umudike South-Eastern, Nigeria

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Abstract

An experiment was carried out in 2012 and 2014 cropping seasons at the National Root Crops Research Institute (NRCRI), farm Umudike (05^{o}, 29N, 07^{o}'31E and 122M above sea level) to determine the effect of the combinations of primextra with paraquat and fusilade forte for weed control in large scale cassava production. There were 10 treatments consisting of 3 herbicides with different rates applied at different weeks after planting. All the herbicides treated plots received a pre-emergence (PE) application of primextra gold 660sc at the rate of 3.0 kga.i/ha, one day after planting. These were followed by directed post emergence application of gramoxone super (paraquat) at 0.5 kga.i/ha and 0.8 kga.i/ha, fusilate forte at 0.3 kgai/ha, 0.45 kaa.i/ha respectively at 6, 10 and 14 weeks after pre-emergence herbicide application, manual weeding at 3 + 8 + 12 weeks after planting (WAP) and a weedy check. The treatments were laid out in a randomized complete block design (RCBD) and replicated 3 times. Application of primextraat 3.0 kga.i/ha, followed by paraquat 0.8 and 0.5 kga.i/ha applied post-emergence at 10 and 14 WAP and 6 and 10 WAP gave an excellent weed control at 12 WAP. Only primextra at 3.0 kg a.i/ha followed by paraquat at 0.8 kga.i/ha applied post-emergence at 10 and 14 WAP controlled weeds excellently up to 16 WAP. Unweeded control treatment gave the least control. Application of primextra gold 660 sc at 3.0kg a.i/ha, followed by paraquat 0.8 kg a.i/ha applied post-emergence at 10 and 14 WAP gave the best cassava mean root yield (22.65 t/ha) in 2012 and 2014. This was followed by manual weeding at 3 + 8 + 12 WAP (19.75 t/ha). The crop phytotoxicity rating was minimal (≤10%), it has no serious injury to the crop. The economic analysis reveals the treatment primextra + paraquat at rate of 3.0 + 0.8 kg ai./ha sprayed at 10 and 14 weeks after planting (WAP) had comparative advantage than the rest of the herbicide used in cassava production. The herbicide yielded N1.07 kobo for every naira invested in the cassava business. The treatment gave an income of N17,200.00.

Keywords: Cassava, herbicides and weed control.

Introduction

The importance of cassava to the agricultural transformation agenda of the Federal Republic of Nigeria has been emphasized (Adesina, 2012). This is evidenced by the fact that cassava produces starch, alcohol, sucrose and quality flour which are of industrial purposes to revive the country's economy. In addition, the crop is important in addressing the hunger alleviation, food security and livelihood challenges of tropical Africa. One way to realize the aim of the agricultural transformation is to increase cassava production through embarking on large-scale production. Weed control is usually a big problem in a situation like this. Manual weeding has been reported to be very ineffective and tedious in any large-scale crop production (Akobundu, 1987).Herbicides have been shown to be a cheaper, more effective and labour saving alternative than manual weed control and is very appropriate to large-scale cassava production.The objective of the study is to determine the effective of combinations of primetra with paraquat and fusillade forte for weed control in large scale cassava production.

Materials and Methods

This study was carried out at the National Root Crops Research Institute (NRCRI), Umudike in June, 2012 and 2014. The land was cleared, ploughed, harrowed and ridged 1m apart. Plot size was 6m x 5m. The test crop was cassava TME 419. The experimental design was randomized complete block design with 3 replications. All the herbicide treated plots received a pre-emergence (PE) application of primextra gold 660 SC at the rate of 3.0 kg a.i/ha, one day after planting. These were followed by directed post emergence applications of gramoxone super (paraquat) at 0.5 kg a.i./ha and 0.8 kg a.i/ha fusillade forte at 0.3kg a.i/ha, 0.45 kg a.i/ha respectively at 6, 10 and 14 weeks after pre-emergence herbicide application. The herbicide was applied with a CP 15 knapsack sprayer, at a spray volume of 220 l/ha. These were compared with hoe-weeded and un-weeded checks. Application of 400kg/ha (15:15:15) fertilizer was made at 8 weeks after planting (WAP). Observations were taken on phytotoxicity evaluations, weed control ratings at 6, 12 and 16 WAP, plant height, plant girth, leaf area, and number of leaves per plant and weight of weeds. Analysis of Variance (ANOVA) procedure was used for statistical analysis of all data and mean comparison was done using Duncan's Multiple Range Test (DMRT). Economic data were collected using cost route approach and analyzed using profitability model (Ezedinma *et al*., 2006).

Results and Discussion

The effect of weed control treatments on weed control at 12 and 16 WAP in 2012 and 2014 are presented in Table 1. The results showed that pre-emergence applications of primextra at 3.0kg a.i./ha, followed by paraquat at 0.80 and 0.50 kg a.i./ha applied post-emergence at 10 and 14 WAP and 6 and 10 WAP gave an excellent weed control at 12 WAP. Weed Control was satisfactory at 12 WAP with treatments containing primextra at 3.0 kg a.i./ha followed by fusilade at 0.45 and 0.30 kg a.i./ha applied post emergence at 10 + 14 WAP and 6 + 14 WAP. Only primextra at 3.0 kg a.i./ha followed by paraquat at 0.8 kg a.i./ha applied post-emergence at 10 and 14 WAP controlled weeds excellently up to 16 WAP. The unweeded control treatment gave the least control.

Cassava Root Yield

Application of primextra gold 660 sc at 3.0 kg a.i./ha, followed by paraquat 0.8 kg.a.i./ha applied post –emergence at 10 and 14 WAP gave the best cassava mean root yield (22.65 t/ha) in 2012 and 2014 (Table 2). This was followed by manual weeding at 3+8+12 WAP (19.73 t/ha), and plots treated with paraquat 0.8 kg a.i./ha applied post emergence at 6 and 10 WAP (10.73 t/ha) .Manual weeding at 3+8+12 WAP recorded the highest number of roots/ha(40167/ha), followed by plots treated with fusillade 0.3 kgai/ha applied post emergence at 10 and 14 WAP. The economic analysis of the weed control treatment presented Table3, showed that primextra + paraquat at the rate of 3.0+0.8 kg a.i/ha sprayed at 10 and 14 weeks after planting (WAP) had comparative advantage than the rest of the herbicides used in cassava production. The manual weeding method could not produce any tangible increase in investment as it loses 78 kobo for every naira invested in the business. However, it could be said that the chemicals (herbicides) were able to yield N1.07 Kobo for every naira invested in the business. Hence, the herbicide could be recommended to relevant actors in the cassava value chain as the income was N17.200.00.

Conclusion

It is concluded that primextra + paraquat at the rate of 3.0 + 0.8 kg ai/ha, sprayed at 10 and 14 weeks after planting (WAP) had comparative advantage than the rest of the herbicides used in cassava production. The chemical yielded N1.07 kobo for every naira invested in the cassava business. The treatment gave an income of N17,200.00. The herbicide primextra + paraquat applied at 3.0 + 0.8 kg ia/ha, could be recommended to relevant actors in the cassava value chain.

Table 1: Effect of weed control treatments on mean weed control rating at 12 and 16 WAP in 2012 and 2014

Treatments	Rate kgai/ha	12 WAP	16 WAP
Primextra + fb fusillade	3.0 +0.45 (POE) 10 + 14 WAP	7.49[bc]	6.78[edf]
Primextra + fb fusillade	3.0 +0.3 (POE) 10 + 14 WAP	7.35[bc]	6.7[edf]
Primextra + fb fusillade	3.0 +0.45 (POE) 6 + 10 WAP	7.39[c]	6.94[ed]
Primextra + fb fusillade	3.0 +0.3 (POE) 6 + 10 WAP	7.70[cb]	6.55[edf]
Primextra + fb paraquat	3.0 +0.8 (POE) 10 + 14 WAP	8.70[b]	8.10[b]
Primextra + fb paraquat	3.0 +0.5 (POE) 10 + 14 WAP	8.0[b]	7.47[cb]
Primextra + fb paraquat	3.0 +0.8 (POE) 6 + 10 WAP	8.35[b]	7.80[cd]
Primextra + fb paraquat	3.0 +0.5 (POE) 6 + 10 WAP	7.85[c]	7.35[cd]
Manual weeding	3+8+12 WAP	10.0[a]	10.0[a]
Unweeded check	-	3.23[d]	2.40[g]

Means followed by the same letter(s) within a column are not significant at P=0.5 (DNMRT)

Table 2: Effect of weed control treatments on mean yield, root number and phytotoxicity in 2012 and 2014

Treatments	Rate kgai/ha	Yield (t/ha)	Root number/ha	Phytotoxicity at 16 WAP
Primextra + fusillade	3.0 +0.45 (POE) 10 + 14 WAP	9.11[bc]	21791[abc]	0.3[de]
Primextra + fusillade	3.0 +0.3 (POE) 10 + 14 WAP	6.80[bc]	36166[a]	0.0[e]
Primextra + fusillade	3.0 +0.45 (POE) 6 + 10 WAP	7.75[cd]	23916[abc]	0.4[de]
Primextra + fusillade	3.0 +0.3 (POE) 6 + 10 WAP	6.10[de]	19500[abc]	0.0[e]
Primextra + paraquat	3.0 +0.8 (POE) 10 + 14 WAP	22.65[a]	18500[cde]	2.0[a]
Primextra + paraquat	3.0 +0.5 (POE) 10 + 14 WAP	6.70[cd]	15667[de]	2.0[a]
Primextra +paraquat	3.0 +0.8 (POE) 6 + 10 WAP	10.73[b]	21000[bcde]	2.0[a]
Primextra + paraquat	3.0 +0.5 (POE) 6 + 10 WAP	7.73[cd]	23667[abc]	1.0[abc]
Manual weeding	3+8+12 WAP	19.73[b]	40167[a]	0.0[e]
Unweeded check	-	1.68[e]	8000[e]	0.0[e]

Means followed by the same letter(s) within a column are not significant at P=0.5 (DNMR)

Table 3: Summary of the Partial budget analysis of some Herbicide for weed Control in Commercial Cassava Production (TMS 419) in south Eastern Nigeria (2012/2014)

Treatment	Rate kgai/ha	Mean Yield (t/ha)	Gross Revenue (N)	Total Variable Cost (N)	Net return (N)	R/N
Primextra + Fusilade (POE)	3.0+0.45 (10+14WAP)	9.11	109320	254125	-144805	-0.43
Primextra + Fusilade (POE)	3.0+0.3 (10 +14 WAP)	6.8	81600	253750	-172150	-0.32
Primextra + Fusilade (POE)	3.0+0.45 (6 +10 WAP)	7.75	93000	254125	-161125	-0.37
Primextra + Fusilade (POE)	3.0+0.3 (6+10 WAP)	6.1	73200	253750	-180550	-0.29
Primextra + Paraquat (POE)	3.0+0.8 (10 +14WAP)	22.65	271800	254600	17200	1.07
Primextra + Paraquat (POE)	3.0+0.5 (10 +14WAP)	6.7	80400	254000	-173600	-0.32
Primextra + Paraquat (POE)	3.0+0.8 (6 +10WAP)	10.73	128760	254600	-125840	-0.51
Primextra + Paraquat (POE)	3.0+0.5 (POE) 6 +10WAP	7.73	92760	254000	-161240	-0.37
Manual weeding	3+8+12 WAP	19.72	236640	305000	-68360	-0.78
Unweeding		1.68	20160	265000	-244840	-0.08

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Evaluation of Seed Hardening Treatments towards Enhancing Seedling Establishment and Mitigation of Moisture Stress in Some Selected Vegetables

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Abstract
Experiment was conducted at the screen house of the Centre for Dryland Agriculture, Faculty of Agriculture, Bayero University Kano, to assess the efficacy of seed hardening treatment on germination and seedling establishment in some selected vegetables. Treatments consist of factorial combinations of three vegetables (cucumber, water melon and pumpkin) and three seed hardening chemicals ($CaCl_2$, KCl and H_2O). These were laid in Completely Randomized Design (CRD) with four replicates. Results of the study revealed significant increase in germination count with 2% KCl treatment. The findings further revealed that soaking pumpkin and water melon resulted in higher canopy temperature irrespective of hardening treatment employed. Hardening vegetable seeds with KCl is thus suggested for enhanced germination, early seedling establishment and performance in the field.
Keywords: Drought, moisture stress, seed hardening and vegetables

Introduction
Drought can be described as a climatic hazard which implies the absence or very low level of rainfall for a period of time, long enough to cause moisture depletion in soil with a decline of water potential in plant tissues. Drought is often accompanied by relatively high temperatures, which promote evapotranspiration and affects photosynthetic kinetics, thus intensifying the effects of drought and further reducing crop yields (Mir *et al*., 2012). Drought tolerance on the other hand is the interactive result of diverse morphological, physiological and biochemical traits and thus, these components could be used as strong selection criteria to screen out appropriate plant ideotype. Implications of developing an effective screening procedure for drought tolerance have been realized utilizing different procedures. The low productivity under rain fed condition is due to use of poor quality seeds, soil moisture deficit, low and erratic rainfall and improper crop management which translates to poor seedling establishment and loss of vigor. The most common impediment faced by most vegetable farmers is the moisture stress effect. Safe guarding seeds during initial stage of germination will give a special impetus for the seed to overcome the moisture stress condition and develop into a vigorous plant. Pre-sowing hardening is one of the best methods that results in modifying the physiological and biochemical nature of seed so as to get the characters that are favorable for drought resistance. Pre-sowing hardening is the result of extensive physiological re-organization induced by dehydration process. It can be done with water, dilute chemical solutions, growth regulating compounds or using commonly available natural tonics like coconut water or milk. Hardening induces early germination, better root and seedling growth, reduces seedling mortality, increases crop population and enhances the yield potential of the crop varieties. Based on aforementioned, there is a need to identify suitable ameliorative measures to overcome the moisture stress effect. This investigation was conceived with a view to study the efficacy of pre-sowing seed hardening with chemicals on germination and seedling establishment in cucumber, water melon, and pumpkin.

Materials and Methods

The experiment was conducted in the screen house of the Centre for Dryland Agriculture, Faculty of Agriculture, Bayero University Kano (Latitute 11° 58' N and Longitude 8°26' E). Treatments consists of factorial combination of three vegetable types (cucumber, water melon and pumpkin) and three seed hardening chemicals (KCl, $CaCl_2$ and H_2O). These were laid in a completely randomized design with four replicates. A total of 36 plastic pots (17.5 x 18cm size) were filled with top soil in the ratio 3:1 (soil and manure). These were kept wet through frequent irrigation for a period of one week so as to ensure complete decomposition of the manure. The seeds were soaked with KCl, CaCl2 and water for 6 hours (Subburamu and Solamalai, 2004), and dried under shade to its original moisture (TNAU, 2016). Three seeds each of the treated cucumber, water melon and pumpkin were sown in each of the 36 pots at 1 cm depth as according to treatment outline. These were irrigated at three days intervals using watering can. Frequent weeding (by hand pulling) was carried out to check for weed infestation. Data were collected on duration of germination (days), germination count (%), and canopy temperature (°c). The survived seedlings were extrapolated using the relation:

$$\text{Seedling Survival} = \frac{\text{Survived seedlings at the end of the experiment}}{\text{Number of seedlings at germination}} \times 100$$

Data on germination duration and count were transformed into arc sine before analysis. These were subjected to analysis of variance using GenStat 17th edition. Significant treatment means were separated using Student Newman Keuls (SNK).

Results and Discussion

The effects of seed hardening treatments and vegetable type on duration of germination, germination count and seedling survival in some selected vegetables are presented in table 1. Results of the study indicated significant ($p< 0.05$) effects of seed hardening treatment on germination count only. This showed that plants treated with KCl recorded significantly higher germination. This was also at par with plants soaked in water. Seed hardening treatment did not how ever recorded any significant effect on duration of germination and seedling survival in the study. This result corroborates with what Basra *et. al.* (2005) reported, that beneficial effects of seed hardening includes accelerated rapid germination and growth rate of seedling, greater germination uniformity and increased germination percent. Similar result was also reported by Bray *et al*. (1995) that seed hardening increased germination rate and uniformity as a result of the metabolic repair processes occurring during imbibition. The results of the study further revealed significant effect of vegetable type on duration of germination only. This showed that it took more days for pumpkin to germinate, which was also at par with water melon but different from cucumber that germinated much earlier. This could be accounted to genotype differences. The germination count and seedling survival were not significantly influenced by vegetable type with all the vegetables exhibiting similar response. Interaction of seed hardening treatment and vegetable type was not significant on all the measured variables in the study. Seed hardening treatment had no significant effect on canopy temperature in this study (table 2). However, results of the study showed significant variation among the vegetables on canopy temperature. This showed that pumpkin recording the highest canopy temperature at 6 WAS only. Cucumber also recorded the lowest canopy temperature in this study. The results further revealed significant interaction of seed hardening and vegetable on canopy temperature at 6 WAS (Table 3). This showed that pumpkin soaked in CaCl, KCl, and H_2O had the highest canopy temperature. This was also at par with water melon treated with CaCl, KCl and H_2O. The lowest canopy temperature was also recorded from cucumber soaked in H_2O. This outcome contradicts with what Mir *et. al.* (2012) reported on the positive role of seed hardening in the mitigation of drought through decreased temperature and evapotranspiration.

Conclusion

The findings of the study showed that hardening with KCl increases germination count. This also revealed that soaking pumpkin seeds with chemicals resulted in higher canopy temperature. It is thus suggested these vegetables be soaked with KCl for effective germination and potentials for early seedling establishment and performance in the field.

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Table 1: Germination count, Duration of Germination and Seedling survival as affected by Seed Hardening Treatment and Vegetable Type in Some Selected Vegetables

Treatment	Germination Count	Germination Duration	Seedling Survival (%)
Chemical (C)			
CaCl	0.83b	5.44	1.57
KCl	1.57a	4.72	1.57
H_2O	1.10ab	4.92	1.57
SE±	0.060	0.408	0.000
Vegetable (V)			
Cucumber	1.09	4.13b	1.57
Pumpkin	1.16	5.69a	1.57
Water Melon	0.98	5.27ab	1.57
SE±	0.060	0.408	0.000
Interaction			
CxV	ns	Ns	ns

Means followed by the same letter(s) within columns are not significantly different using Student Newman Keuls (SNK) at 5% probability level

Table 2: Effects of Seed Hardening Treatment and Vegetable Type on Canopy Temperature of Some Selected Vegetables at BUK in 2017

Treatment	Weeks After Sowing (WAS)		
	3	6	9
Chemical (C)			
CaCl	34.25	24.51	26.93
KCl	33.22	24.26	26.89
H_2O	33.72	23.78	27.76
SE±	0.675	0.194	0.545
Vegetable (V)			
Cucumber	33.06	23.30c	26.93
Pumpkin	33.56	25.02a	27.34
Water Melon	34.57	24.22b	26.96
SE±	0.675	0.194	0.545
Interaction			
CxV	ns	*	ns

Means followed by the same letter(s) within columns are not significantly different using Student Newman Keuls (SNK) at 5% probability level

Table 3: Interactions of Seed Hardening Treatment and Vegetable Type on Canopy Temperature at 6 WAS during 2017 at BUK

	Vegetable Type		
Chemical	Cucumber	Pumpkin	Water Melon
CaCl	24.33ab	25.10a	24.10ab
KCl	23.38b	24.93a	24.47ab
H_2O	22.21c	25.30a	24.10ab
SE±		0.336	

Means followed by the same letter(s) within columns are not significantly different using Student Newman Keuls (SNK) at 5% probability level
BUK= Bayero University, Kano

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Effects of Urea Supergranule, Rate and Time of Application of Biostimulant on Rice (*Oryza sativa* L.) Yield in Sudan Savanna

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Abstract
A field experiment was carried out in the Institute for Agricultural Research (IAR) Farm at Kadawa (11°39'N, 08°02'E) in the Sudan Savannah agro ecological zone of Nigeria, in the 2015-2016 dry season to study the response of irrigated rice as influenced by urea supergranule, rate and time of application of biostimulant. The experiment consisted of factorial combination of three rates of urea supergranule (USG) (0,1.8, 2.7g/granule), three rates of bio-stimulant (0, 50 and 100 ml/100L of water) and four times of application of bio-stimulant [3 (tillering stage) and 5 (panicle initiation stage) weeks after transplanting (WAT) (A), 3 and 10 (milky stage) WAT (B), 5 and 10 WAT (C) and 3, 5 and 10 WAT (D)]. These were laid out in a randomized complete block design and replicated three times. The results showed that 2.7g size of USG in combination with 50ml/100L of water at 3 and 10WAT increased number of effective tillers, relative growth rate (RGR), weight of paddy per panicle and paddy yield of irrigated rice.
Keywords: Irrigated rice, Urea supergranule, Rate and Time of Biostimulant

Introduction
Rice (*Oryza sativa* L.) belongs to the family Poaceae. It is one of the major food crops in the tropics, particularly in Asia. It is the extensively cultivated crop for half of the world's population (FAO, 2010). The production and consumption of rice is growing faster in trend than for other staple foods (Selbut, 2003). World rice production trend increased from 437.1 million tonnes in 2008/2009 to 480.4 million tonnes in 2017/2018 (Anonymous, 2018). However, FAO's first forecast of world paddy production in 2018 sees global output staging a 10.3 million tonnes annual expansion to a new high of 769.9 million tonnes (510.6 million tonnes, milled basis) (FAO Rice Market Monitor (RMM), 2018). According to NAERLS and FDAE (2014), rice production estimate for 2014 wet season in Nigeria is about 6.734 million tonnes with Kwara state producing 548.7 million tonnes and 1.9million tonnes in Akwa Ibom state. Several factors pose as constraints in rice production which contributes to the low level of paddy production; resulting to insufficiency in meeting the demands of the consumers. However, the availability of suitable high yielding varieties and quality seeds are also a problem. Also, low soil fertility due to soil erosion resulting in loss of plant nutrients and moisture, low and imbalanced use of fertilizers, heavy infestation of weeds and insects/pests such as blast and brown spot and poor attention for their timely control (upland and rainfed lowland). Poor crop plant population in case of broadcast sowing method resulting in uneven germination (upland and direct seeded lowlands). The area under rice cultivation has almost been exhausted; the way to sustain production is to increase the productivity per unit of area. Rice provides 21% of energy and 15% of protein for human, its quantity and quality requires major attention (Zibaee, 2013 and Gnanamanickam, 2009). Nitrogen fertilizer is one of the major nutrient elements for crop production that can contribute a lot for higher rice yield. It is a fact that rice plant requires more nutrients to produce more yields. Slow release nitrogenous fertilizer increases the yield and nitrogen uptake by rice due to less loss of nitrogen from the soil (IFDC, 2014). Urea Supergranule (USG) fertilizer is a simple physical modification of ordinary urea fertilizer. Urea Deep Placement (UDP) is one innovative response (technique of placing Urea Supergranule) we need to increase farmer

productivity (particularly for cereals) in sustainable ways. This technique involves the use of briquetted urea buried several inches deep between 4 rice stands (Tarfa and Kiger, 2013). They make it possible to place the nitrogen in the anaerobic soil layer which is where plant root development takes place (Freney and people 1995). Balanced use of plant nutrients and method of applying required nutrients in standing water using the deep placement of urea supergranules by the applicator. Research has also shown that application of recommended rate of nitrogen fertilizer to lowland rice by broadcasting practiced by farmers is inefficient, wasteful and expensive in terms of fertilizer cost (Johnson *et al*., 2013). Application of urea-N plays a vital role in vegetative growth, development and yield of rice. Positive responses has been reported on growth and yield of rice using urea supergranule by 7-10 days after transplanting (Tarfa and Kiger, 2013), thus the choice of nitrogen rates (1.8 and 2.7g/granule) to determine the optimum became imperative. This also is necessary to minimise losses and avoid wastage of nitrogen fertilizer which is not readily available and affordable which in turn increases rice productivity. In order to increase rice productivity, it is necessary to find agent that can improve and promote rice growth.

The use of Bio-stimulants for this research will foster plant growth and development throughout the crop life cycle from seed germination to plant maturity by improving the efficiency of the plant's metabolism to induce yield increases, improve crop vigour and enhanced crop quality. Despite the positive potentials of USG and bio-stimulant, improper use of the rates and time of application can also limit productivity. The knowledge about this research was conducted to improve the production of irrigated rice by maximizing the use of urea supergranule, rate and time of application of bio-stimulant.

Materials and Methods

An experiment was conducted at the Institute for Agricultural Research Irrigation Farm, Kadawa (11°39'N, 08°02'E) located in the Sudan Savannah agro ecological zones of Nigeria, during 2015-2016 dry season. Prior to planting, random soil samples were collected from experimental site at 0-15 and 15-30 cm depth using soil auger and bulked for physical and chemical analysis. Meteorological data during period of the experiment were obtained from Institute for Agricultural Research Kadawa Meteorological Station. Treatments consisted of three rates of USG (0, 1.8, 2.7g/granule), three rates of bio-stimulant (0, 50 and 100 ml/100L of water) and four times of application of bio-stimulant [3 (tillering stage) and 5 (panicle initiation stage) weeks after transplanting (WAT) 3 and 10 (milky stage) WAT, 5 and 10 WAT and 3, 5 and 10 WAT]. These were laid out in a Randomized Complete Block Design in a split plot arrangement replicated three times. The gross and net plot sizes were 3.0m X 5.0m (15m^2) and 2.2m X 4.2m (9.24m^2) respectively. Glyphosate was applied at the rate of 2 kg a.i ha^{-1} on the land in order to control weeds which after 14 days of application, the site was harrowed to obtain a fine tilth. Ridging was done at 75cm apart and the field subdivided into plots according to the experimental layout. Seeds were sown manually at the nursery and transplanted to the field three weeks after sowing using an intra-row spacing of 20cm by 20cm. FARO 44 (SIPI-692033) with a maturity period of 110 – 120 days was sourced from National Cereal and Research Institute, Badeggi (NCRI), Niger State. Seeds were transplanted according to treatment on the 17th March, 2016. Crops were irrigated every five days up to 30 days after sowing and later at seven days interval up to hard dough stage when irrigation was stopped. Maxicrop an organic bio-stimulant, was applied as foliar spray at the rate of 0, 50 and 100ml/100L of water using a knapsack sprayer of 16L at 3 and 5 WAT, 3 and 10 WAT, 5 and 10 WAT and 3, 5 and 10 WAT. It contains NPK from organic sources and has active ingredients from natural growth compounds, carbohydrates, protein precursors and nutrients. Nitrogen was applied at the rate of 120 kg N, 40 kg P_2O_5 and 40 kg K_20 per hectare. The nitrogen fertilizer was applied as split, half of the nitrogen fertilizer together with 60kg P_20_5 and 60 kg K_2O was applied once at land preparation using NPK (15:15:15) while the second half of nitrogen fertilizer was applied using USG ten days after transplanting. USG was placed 5cm deep into the soil, between four rice stands and applied to every other row and to every other plant. Each plot was hand pulled and hoe weeded at 4 and 8 WAT. The crops were harvested at full physiological maturity and threshed. Ten rice plants from each plot were randomly tagged and data were collected on numbers of effective tillers, relative growth rate (RGR) (g. g. wk^{-1}), weight of paddy per panicle (g) and paddy yield (kg ha^{-1}). These were subjected to Analysis of Variance as described by Gomez and Gomez (1984) using SAS (2007) software. Duncan's Multiple Range Test (DMRT) at 5 % probably level (Duncan, 1955) was adopted for treatment mean separation.

Results and Discussion

The results of soil physical and chemical properties are shown in Table 1. The soil was loamy with neutral to slightly alkaline pH ranging from 6.99 - 7.64. The soil nutrient status ranged from 7.7 - 8.8 g kg^{-1} organic Carbon, 0.28 - 0.36g kg^{-1} total Nitrogen, 3.60 - 9.50 mg kg^{-1} of available Phosphorus while exchangeable bases values were Calcium (2.80 – 3.00 cmol kg^{-1}), Magnesium (0.71 – 0.81cmol kg^{-1}), Potassium (0.13 cmol kg^{-1}) Sodium (0.54 cmol kg^{-1}) as well as Cation Exchange Capacity (CEC) 4.37 - 4.61 cmol kg^{-1} of soil. Table 2 shows the growth and yield of irrigated rice as influenced by urea supergranule, rate and time of application of biostimulant. The application of urea supergranule differed significantly on all the parameters tested except number of effective tillers. The application of 1.8g size of USG recorded the highest RGR while 2.7g size of USG significantly recorded the highest paddy weight and grain yield. There was no significant difference in number of effective tillers with the application of biostimulant rate. However, 0ml recorded the highest RGR which was at par with 100ml. The application of 50ml biostimulant rate recorded the highest paddy weight and grain yield which was statistically similar with 100ml in paddy weight. The effect of time of application of biostimulant was significant on all the parameters studied except RGR. Application at 3 and 10WAT resulted in the significantly highest grain yield followed by 5 and 10WAT and 3, 5 and 10WAT. Interaction among factors studied was significant for the weight of paddy per panicle and grain yield. Weight of paddy per panicle and grain yield followed the same trend in the interaction between USG and biostimulant rate. Where increase in USG from 1.8 to 2.7g size of USG significantly increased weight of paddy per panicle and grain yield. However, 2.7g size of USG at 50ml/100L of water of biostimulant application rate recorded the highest values while 1.8g size of USG at 0ml/100L of water of biostimulant application rate obtained the lowest values. The application of USG from 1.8 to 2.7g size increased weight of paddy per panicle in the interaction between USG and time of application of biostimulant. However, at 3 and 10WAT time of biostimulant application, the highest weight of paddy per panicle was obtained by the application of 2.7g size of USG compared to all other treatments. The lowest weight of paddy per panicle was obtained by the application of 1.8g size of USG at 3 and 5WAT time of biostimulant application. The following trend was obtained in grain yield. The application of biostimulant rate at 50ml/100L of water at 3 and 10WAT resulted in the heaviest weight of paddy per panicle and grain yield compared with 0ml/100L of water at 3 and 5WAT, which obtained the lightest weight of paddy per panicle and grain yield. Further increase in the rate of biostimulant applied from 50 to 100ml/100L of water resulted in no significant increase in marketable yield. Nitrogen is the most important element for cereal as it plays a crucial role on the growth and development due to its major role in cell division, elongation and enlargement. Rice with a high yield component variation might be due to differences in environmental and soil conditions. The significant variation According to Fofana (2012) the main constraint to achieving high rice productivity in Africa is the increased deficiency of major nutrients and particularly nitrogen (N). The application of 2.7g size of USG performed best among the treatments in respect to yield and yield components of rice. This could be attributed to the presence of adequate ammonium in the soil by the deep placement of USG that met the requirement of the plant at the early stage of growth. This was in accordance with Jing Xiang *et al*., (2013) who studied the effect of deep placement of nitrogen fertilizer on growth, yield, and nitrogen uptake of aerobic rice and reported that the field micro-plot experiment showed that urea and urea super granules (USG) deep placement increased grain yield of aerobic rice by 1.66 t ha^{-1} in continuous aerobic rice cultivation. Jayanta *et al.,* (2017) reported that time of application at vegetative, tillering and panicle initiation stages had significant effect on rice with higher grain yield, number of tillers, straw yield using seaweed extract (a constituent of biostimulant). Several researchers observed the influence of urea supergranule (Hasanuzzaman *et al*., 2013, Qurashi *et al*., 2013); biostimulant rate (Srivastava *et al.,* 2010) and time of application of biostimulant (Sunapri *et al.,* 2010) on growth and yield component of rice. According to Ganapathy and Sivakumar (2014) increased growth parameters at lower concentration may be due to the presence of higher levels of N, P, K in the seaweed extract of *C.scalpelliformis*. The increase in panicle weight and grain yield could be attributed to more assimilate partitioning and dry matter production for grain filling.

Conclusion

Based on the results obtained and findings of this study, it can be concluded that the application of 2.7g size of USG in combination with 50ml/100L of water at 3 and 10WAT performed better and resulted in the highest growth and yield of irrigated rice.

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Table 1: Physical and Chemical Properties of Soils from Kadawa at 2015-2016 Dry Season

Soil Properties	**Kadawa**	**Kadawa**
Soil depth	0-15cm	15-30cm
Physical composition unit		
Sand (g kg^{-1})	770	680
Silt (g kg^{-1})	110	180
Clay (g kg^{-1})	120	140
Textural class	Loamy sand	Loamy sand
Chemical composition		
pH in water	6.99	7.64
pH in 001 M $CaCl_2$	6.58	6.97
Organic Carbon (g kg^{-1})	0.88	0.77
Total Nitrogen (g kg^{-1})	0.28	0.36
Available Phosphorus (mg kg^{-1})	9.50	6.43
Exchangeable Bases (cmol kg^{-1})		
Ca^{++}	3.00	2.80
Mg^{++}	0.80	0.71
K^{+}	0.13	0.13
Na^{+}	0.54	0.54
CEC	4.37	4.16

Soil sample analysed at Agronomy Department, A B U, Zaria.

Table 2: Growth and yield rice as influenced by urea supergranule, rate and time of application of biostimulant in 2015-2016 dry season

Treatment	Number of effective tillers	Relative growth rate (9-12WAT)	Weight of paddy per panicle (g)	Grain yield (kg ha^{-1})
Urea supergranule (U) g				
0	9.68	0.37b	1.93b	1693.54b
1.8	9.71	0.43a	1.52c	1351.59c
2.7	9.55	0.33c	2.35a	1997.68a
SE ±	0.35	0.005	0.002	3.935
Biostimulant Rate (B) ml				
0	9.61	0.39a	1.76c	1549.69c
50	9.60	0.36b	2.12a	1816.81a
100	9.73	0.38ab	1.92b	1676.31b
SE ±	0.35	0.005	0.002	3.935
Time of application (T) WAT				
3 and 5	8.96b	0.37	1.86d	1625.66d
3 and 10	9.60ab	0.37	2.01a	1746.19a
5 and 10	10.35a	0.38	1.95b	1697.71b
3, 5 and 10	9.68ab	0.39	1.92c	1654.18c
SE ±	0.404	0.006	0.002	4.544
Interaction				
UxB	NS	NS	**	**
UxT	NS	NS	**	**
BxT	NS	NS	**	**
UxBxT	NS	NS	NS	NS

Means followed by same letter(s) within the same column and treatment group are not significantly different at 5% level of probability using DMRT. WAT = Weeks after transplanting, **= significant at 1% level of probability. NS = Not significant.

Table 3: Interaction between urea supergranule and biostimulant rate on weight of paddy per panicle (g) and grain yield (kg ha^{-1}) of rice at harvest at Kadawa in 2016 dry season

Treatment	Biostimulant Rate (ml)		
Urea Supergranule (g)	0	50	100
		Paddy weight (kg ha^{-1})	
0	1.86ef	2.01cd	1.94de
1.8	1.32h	1.74fg	1.52gh
2.7	2.13bc	2.63a	2.30ab
SE ±		0.004	
		Grain yield (kg ha^{-1})	
0	1585.36ef	1797.28bcd	1698.1 cde
1.8	1196.90h	1475.80fg	1382.07gh
2.7	1866.94bc	2177.37a	1948.74ab
SE ±		6.816	

Means followed by the same letter(s) are not significantly different at 5% of probability using DMRT

Table 4: Interaction between urea supergranule and time of application of biostimulant weight of paddy per panicle (g) and grain yield (kg ha^{-1}) of rice at harvest at Kadawa in 2016 dry season

Treatment	Time of Application of Biostimulant (weeks)			
Urea Supergranule (g)	**3 and 5**	**3 and 10**	**5 and 10**	**3, 5 and 10**
		Paddy weight (kg ha^{-1})		
0	1.90gh	1.97de	1.95ef	1.93fg
1.8	1.43k	1.60hi	1.55ij	1.51jk
2.7	2.27cd	2.47a	2.37ab	2.31bc
SE ±		0.004		
		Grain yield (kg ha^{-1})		
0	1654.36gh	1734.12de	1705.98ef	1679.74fg
1.8	1289.29k	1416.75hi	1381.80ij	1318.53jk
2.7	1933.35cd	2087.72a	2005.37ab	1964.29bc
SE ±		7.870		

Means followed by the same letter(s) are not significantly different at 5% of probability using DMRT

Table 5: Interaction between rate and time of application of biostimulant weight of paddy per panicle (g) and grain yield (kg ha^{-1}) of rice at harvest at Kadawa in 2016 dry season

Treatment	Time of Application of Biostimulant (weeks)			
Biostimulant Rate (ml)	**3 and 5**	**3 and 10**	**5 and 10**	**3, 5 and 10**
		Paddy weight (kg ha^{-1})		
0	1.69jk	1.83ij	1.79ij	1.69k
50	2.04cd	2.23a	2.14ab	2.10bc
100	1.86gh	1.98ef	1.94ef	1.91fg
SE ±		0.004		
		Grain yield (kg ha^{-1})		
0	1493.78k	1606.57ghi	1574.94ij	1523.48jk
50	17421.88cd	1913.95a	1830.15ab	1780.29bc
100	1640.34gh	1718.07de	1688.05ef	1658.78fg
SE ±		7.870		

Means followed by the same letter(s) are not significantly different at 5% of probability using DMRT

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Response of Sorghum (*Sorghum bicolor*) to Different Planting Arrangements and Cow Dung Amended with Urea in Kabba, Kogi State, Nigeria

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Abstract
The experiment was carried out for two consecutive growing seasons (2016 and 2017) at the research site of the Lower Niger River Basin Development Authority, Ejiba, Kogi State of Nigeria The design of the experiment was a Randomized Complete Block Design (RCBD) using factorial arrangement. The treatments consisted of two factors which are planting arrangement (G1=20 cm by 1 plant and G2= 40 cm by 2 plants) and amendment (T2=7.5t/ha plus 62.5 kg urea, T3=5.0t/ha plus 125 kg urea, T4=2.5t/ha plus 187.5 kg urea, T1=250 kg urea, 10t/ha cow dung and no urea, no cow dung (control). Data were taken on growth and yield characters of sorghum. Data on all parameters and response variables were subjected to analysis of variance (ANOVA), means were separated using the Least Significant Difference (LSD) method at 5 % level of probability. From the findings of this work, it was observed that plots with 20 cm by I plant were significantly better in growth and seed yields than plots with 40 cm by 2 plants. Sorghum with either urea or cow dung alone produce growth and yield characters significantly better than sorghum in the control plot. Plots with combine application of cow dung manure and urea compete favourably with sorghum treated with urea at optimum rate. Plot with5.0 t/ha cow dung + 125kg urea had yield that similar to urea at optimum rate, since the cause of the inputs will be reduced. It is therefore recommended to sorghum farmers in the study area. For optimum production of sorghum farmer should plant at 20 cm by 1 plant.
Keywords: Sorghum, planting arrangement, cow dung and urea

Introduction
Sorghum is one of staple food that is indigenous to Africa (IFPRI, 1983). In Nigeria, sorghum occupies 45-50% of land area under cereal and of the total national hectare, close to 99% is found in the savanna zone (Agbede, 2006). It is drought-resistant crop (Rooney *et al*., 1987 and this accounted for many species grown in zones characterized by low and erratic precipitation (Nicou *et al.,* 1990). Many factors are responsible for the low grain yield in sorghum (Abimiku *et al*., 2002). Chief among the factors are soil nutrient depletion, improper planting arrangement which often lead to competition for water, sunlight and soil nutrients among crops. Inorganic fertilizer is scarce and is rarely used by sorghum farmers since the crop is known to be hardy and adapted to adverse soil conditions. The use of inorganic fertilizers alone such as urea is not sustainable, although urea is major source of nitrogen. Nitrogen is a vitally important plant nutrient, the supply of which can be controlled by man (Adediran and Banjoko, 1995; Shanti et al., 1997). In plant nutrition, nitrogen is involved in the composition of all amino acids, proteins and many enzymes. Nitrogen is also part of the puric and pyrimidic bases, and therefore is a constituent of nucleic acids (Mills and Jones, 1996). Continuous use of inorganic fertilizer alone apart from contributing to soil acidity, it also leads to soil physical and chemical degradation. Sustainable agricultural production incorporates the idea that natural resources should be used to generate increase output without depleting the natural resources base. In this context, integrated nutrients management maintains soils as store houses of plant nutrients that are essential for crop growth. The basic principle behind this concept is to use both the chemical fertilizers and organic manures in most efficient manner because of their limited availability and higher prices. The complementary use of chemical fertilizers and organic manures will augment the efficiency of chemical fertilizers as well as that of organic manures. Nambiar and Abnol,

(1989) reported that integrated use of organic and inorganic fertilizers has been found to be promising in obtaining sustainable crop productivity on a long term basis under modern intensive cropping, besides meeting the nutrients turn over in soil plants system. Therefore, the use of organic manure to supplement inorganic fertilizer use, as an integrated management strategy, is of paramount importance to reducing the cost of soil mineral input, maximizing yields and sustaining sorghum as well as other food crops production in Nigeria. In the rural communities, cheaper sources of organic inputs especially cow dung manure is in abundance. A number of studies carried out on organic and inorganic fertilizer combination in cereals production, have attested to a positive interaction between them when simultaneously applied. Due to abundance of major cattle herds in guinea savanna zone, there is need to study the response of sorghum to cow dung manure amended with urea. Therefore the objective of this project is to determine the response of sorghum (*sorghum bicolor*) to different planting arrangement and cow dung amend with urea in Kabba, Kogi State, Nigeria.

Materials and Methods

Description of Experimental Site

The experiment was carried out for two consecutive growing seasons (2016 and 2017) at the research site of the Lower Niger River Basin Development Authority, Ejiba, Kogi State of Nigeria (Lat. 8˚18'N and Long. 5˚39'E). The site is 246 m above sea level, in the southern Guinea savanna agro-ecological zone of Nigeria, having hot dry seasons and also cool wet seasons. The rainy season spans from April to November and attains peaks in June while the dry season extends from December to March. The mean annual rainfall is 1570 mm per annum with annual temperature range of 18 ˚C – 32 ˚C and mean relative humidity of 60% (Meteorological Data, 2011). The major soil order within the experimental site is ultisol (Ajiboye and Ogunwale, 2010). The experiment was sited within a 14 ha agricultural field that has been continuously mechanically tilled for arable crops (maize, cowpea, sorghum, garden egg, okra, tomato and cassava) production for over twenty years.

Field Layout and Treatments

The experiment was carried out in a Randomized Complete Block Design (RCBD) using factorial arrangement and replicated three times, with a plot size of (5m×4m). The treatments consisted of two factors. These factors are planting geometry (G1=20 cm by 1 plant and G2= 40 cm by 2 plants) and application of cow dung and urea either singly or in combination and a control (T2=7.5t/ha plus 62.5 kg urea, T3=5.0t/ha plus 125 kg urea, T4=2.5t/ha plus 187.5 kg urea, T1=250 kg urea, 10t/ha cow dung and no urea, no cow dung (control). Cow dung manure was collected a month prior to application, and was manually incorporated to the upper 10-15 cm of the soil a week before sorghum planting while urea was applied at two weeks after sorghum planting. The sorghum seeds were obtained from National Cereal Research Institute, Badeji, Niger state. Plots were weeded twice at 30 and 45 days after emergence. Insect pests were controlled using Dimethoate 40-D w/v.

Soil sampling and chemical analysis

Before the commencement of the experiment in 2016, surface soil samples (0 – 15cm depth) were taken randomly from the experimental site. The samples were bulked, air dried and sieved using a 2mm sieve and analyzed for particle size, soil organic matter total N, P, K, Ca, Mg and pH. Soil samples (0 – 15cm depth) were also collected at crop maturity on plot basis and were subjected to routine physical and chemical analyses. The samples were taken, bulked and sub sampled as described by Cartel (1993). Particle size analysis was done using hydrometer method (Bouyoucos, 1962) while organic matter was determined by the procedure of Walkley and Black using the di -chromate wet oxidation method (Nelson and Sommers, 1982). Total N was determined by micro – Kjeldahl digestion method (Bremner, 1965) and available P was by Bray – 1 extraction followed by molybdenum blue colorimetry (Bray and Kurtz, 1945). Exchangeable K, Ca and Mg were extracted by EDTA titration method (Jackson, 1962). Soil pH was determined in 1:2 soils – water ratio using digital electronic pH meter.

Determination of growth and yield parameters

Fifteen plants were randomly selected at the center of each plot for data collection. Plant height and leaf area per plant were determined at 120 days after planting when the sorghum plant reaches its peak growth. Plant height was measured with a measuring tape from tagged plants from the ground level to the tip of the panicle. Ten leaves were taken randomly the length (L) and weights (w) were measured and the leaf area was taken in cm and calculated as follows: **Leaf**

area =L.wX0.74 (Yagoub and Abdelsalam, 2010). A vernier caliper was used to measure stem diameter in (cm). Numbers of leaves were also determined by counting.

Statistical analysis

Data on all parameters and response variables were subjected to analysis of variance (ANOVA) using the GenStat statistical package (GenStat, 2007). Means were separated using the Least Significant Difference (LSD) method at 5 % level of probability.

Results and Discussion

The properties of the soil of the site of the experiment are shown in Table 1. The soils are sandy clay loam. Soil of Kabba is slightly acidic (6.21) and high in bulk density (1.62 glcm^3). Organic matter, total N, available phosphorus (P) and exchangeable potassium (K) were 1.93%, 0.13%, 6.14 mg/kg and 0.27 (cmol/kg) respectively. Pre-planting soil analysis indicated that the soil of the experimental site was low in soil nutrients status. The low nutrient status may be due to leaching of basic cations due to intensive rainfall or perhaps due to the parent material of quarts and sesquioxides which are poor in plant nutrients. This agreed with the findings of Nnaji, et al. (2005) and Aberger (2006) who reported large losses of basic cations due to leaching and high intensive and duration of rainfall. Application of organic manure especially cow dung will be of great benefit to the crop. The chemical compositions of the cow dung used are presented in Table 2. The results show that. The material was rich in nutrients. Application of this material, will improve the fertility content of the soil, and improve the performance of sorghum. Effects of planting arrangement and cow dung manure amend with urea are presented in Table 3. Plant height, stem girth and leaf area show significance response to planting arrangement. Sorghum planted at 20 cm by 1 plant were taller, thicker and produce higher leaf area compared to sorghum planted at 40 cm by 2 plants. Table 3 also indicated that all the crops with either urea or cow dung manure alone and their combinations were significantly taller, thicker and produced leaf area higher than the control. All the integrated applications compete favourably with the urea fertilizer apply at optimum rate. Among the integrated application plots with 2.5t/ha cow dung + 187.5kg urea had highest valves of plant height (5.48 m), stem girth (3.59 cm) and leaf area (1.84m^2). Days to 50% flowering was not significantly affected and this could be attributed to the response of sorghum to change in day length which is common among sorghum cultivars. Table 4 presents the effect of planting arrangement and amendment on yield characters of sorghum. Panicle length, seeds per panicle, 1000 seeds weight and grains yield were better in the sorghum planted at 40 cm by 1 plant than sorghum with 2 plants at 40 cm intervals. All plots with amendment were better than the control. Although, plots with urea application recorded the highest yield, the yield was not significantly difference from plots with combined application of urea and cow dung at reduce rate. Among the plots with amendment cow dung alone recorded the least value of grain yield (1.15). Plots with 20 cm at 1 plant were better growth and yield compare to plants at 40 cm by 2 plants. The observed reduction in the height, thickness and leaf area in crop with two plants at 40 cm intervals could be due to competition for soil and air resources that nutrients that could occur among the plants. Sorghum plants planted singly enjoy ample soil volume and consequently had greater soil nutrient interception. This report supports the work of Caliskan, 2007. Sorghum with amendment produce better growth and yield compare to the control. This result is expected because many researchers had reported that sorghum response to both organic and inorganic sources of nutrient and their combinations. Urea fertilizer releases it nutrients quickly to the crop while organic sources such as animal manure can be an effective source of major nutrients (N, P, & K) when applied at optimum rates and can influence the temporal dynamics of nutrient availability (Paul & Beauchamp, 1993), increase water use efficiency of crops (Carter *et al*., 1992) decrease soil P fixation and enhances P availability in the soils (Iyamuremye & Dick, 1996) through its effect on physical and chemical properties of the soil. Plots with combine application of cow dung manure and urea compete favourably with urea application at optimum rate. This indicates that cow dung manure may have other beneficial effects on the soil in addition to the contribution from the urea. This observation agrees with Jama et al., (2000) when they asserted that, organic materials, apart from being rich in nutrients including calcium, nitrogen and phosphorus, can increase the soils moisture retaining capacity, which helps to improve and maintain the biological and physiochemical qualities of the soil thereby improving the growth performance of sorghum.

Conclusion

From the findings of this work, it can be concluded that plots with 20 cm by I plant were significantly better in growth and seed yields than plots with 40 cm by 2 plants. Plots with combine application of cow dung manure and urea compete favourably with urea application at optimum rate. Plot with5.0t/ha cow dung + 125kg urea had yield that similar to urea at optimum rate, is therefore recommended to sorghum farmers in the study area. Yield can also be improved by planting sorghum at 20 cm by 1 plant.

Table 1: Result of pre-planting soil analysis

Properties	
Sand (%)	67.1
Silt (%)	16.2
Clay (%)	16.7
Soil Texture	Sand Clay Loam
pH (H_20)	6.21
Bulk Density (g/cm^3)	1.62
Total Porosity (%)	41.41
Organic Matter (%)	1.93
Total Nitrogen (%)	0.13
Available P (mg/kg)	6.14
Exchangeable K (cmol/kg)	0.27
Exchangeable Ca (cmol/kg)	2.13
Exchangeable Mg (cmol/kg)	1.32

Table 2: Chemical composition of cow dung manure used

Nutrients	*Values*
Organic Carbon (%)	14.51
Total N (%)	2.10
C/N	6.91
Phosphorus (%)	0.53
Potassium (%)	1.83
Calcium (%)	1.28
Magnesium (%)	0.39

Table 3: Growth parameters of sorghum as influenced by planting geometry and cow dung amend with urea

Treatment	Plant height (m)			Stem girth (cm)			Leaf area (m2)			Days to 50% flowering		
Planting Geometry	**2016**	**2017**	**Mean**	**2016**	**2017**	**Mean**	**2016**	**2017**	**Mean**	**2016**	**2017**	**Mean**
PG1	6.22	6.07	6.15	3.54	3.21	3.38	1.60	1.76	1.68	119	118	119
PG2	5.35	5.31	5.33	3.16	2.91	3.04	1.48	1.63	1.56	119	119	119
LSD	0.51	0.36	0.47	0.21	0.16	0.23	0.06	0.09	0.09	ns	ns	ns
Amendment												
AM1	5.31	4.13	4.72	3.14	2.91	3.03	1.69	1.59	1.64	119	120	120
AM2	5.53	4.11	4.82	3.13	3.01	3.07	1.65	1.53	1.59	120	118	119
AM3	6.11	4.84	5.48	3.77	3.41	3.59	1.72	1.84	1.78	119	120	120
AM4	6.21	5.26	5.74	3.11	3.74	3.43	1.74	1.61	1.68	119	119	119
AM5	5.46	4.07	4.77	2.64	2.63	2.64	1.11	1.19	1.15	118	119	119
AM6	3.74	3.14	3.44	1.86	1.44	1.65	0.67	0.68	0.68	120	119	120
LSD	1.31	0.68	1.06	0.62	1.02	0.78	0.36	0.40	0.42	ns	ns	ns
PG Vs AM	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Legend: AM1=7.5t/ha cow dung + 62.5kg urea, AM2=5.0t/ha cow dung + 125kg urea, AM3=2.5t/ha cow dung + 187.5kg urea, AM4=250kg urea/ha, AM5=10t/ha cow dung and AM6=no cow dung and no urea (control), PG1=20cm by one plant, PG1=40cm by two plants

Table 4: Yield parameters of sorghum as influenced by planting geometry and cow dung amend with urea

Treatment	*Panicle length (cm)*			*Seeds per panicle*			*1000 seed weight (g)*			*Grains yield (t/ha)*		
Planting Geometry	**2016**	**2017**	**mean**	**2016**	**2017**	**mean**	**2016**	**2017**	**mean**	**2016**	**2017**	**mean**
PG1	52.6	53.4	53.0	1594	1581	1588	176.6	158.0	167.3	1.38	1.49	1.44
PG2	43.4	41.8	42.6	1358	1274	1316	159.8	144.1	152.0	1.18	1.14	1.16
LSD	8.6	10.4	8.7	146	268	243	14.8	11.6	13.4	0.16	0.32	0.22
Amendment												
AM1	49.4	47.8	48.6	1844	1518	1681	146.1	139.9	143.0	1.24	1.38	1.31
AM2	48.9	50.6	49.8	1860	1694	1777	174.6	181.1	177.9	1.46	1.31	1.39
AM3	51.1	48.6	49.9	1541	1441	1491	146.6	151.5	149.1	1.38	1.28	1.33
AM4	49.1	48.2	48.7	1788	1641	1715	174.8	181.6	178.2	1.49	1.31	1.40
AM5	32.6	31.9	32.3	1376	1374	1375	134.1	140.2	137.2	1.16	1.14	1.15
AM6	27.6	30.4	29.0	943	917	930	104.1	113.4	108.8	0.57	0.61	0.59
LSD	4.1	0.9	2.2	211	364	406	26.7	23.1	23.8	0.48	0.43	0.36
PG VS AM	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Legend: AM1=7.5t/ha cow dung + 62.5kg urea, AM2=5.0t/ha cow dung + 125kg urea, AM3=2.5t/ha cow dung + 187.5kg urea, AM4=250kg urea/ha, AM5=10t/ha cow dung and AM6=no cow dung and no urea (control)

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Influence of Inoculation with Rhizobia and Mycorrhiza on Yield Components of Soybean in Northern Guinea Savanna Alfisol

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Abstract
Tripartite symbiosis involves association of legume, Rhizobia and Mycorrhiza. This association is reported to be more effective than either rhizobial or mycorrhizal inoculation alone in respect to yields of plants. A greenhouse pot experiment was conducted to evaluate the response of soybean to co-application of rhizobia and Mycorrhiza on yield components of soybean in the northern Guinea savanna of Nigeria. The treatments consisted of 3 levels of N (+N, Rhizobia and –N), 3 levels P (+P, Mycorrhiza and –P) and 3 levels of N and P combinations (+N +P, Rhizobia + Mycorrhiza and –N –P) giving 9 treatments replicated 3 times. The result indicated that significantly higher ($p<0.05$) root dry weight was recorded by inoculation with Mycorrhiza with magnitude of 72% over control. There was also significant ($p<0.001$) difference in dry matter yield of soybean between the levels of P where inoculation with Mycorrhiza and application of P recorded a 69% and 67% dry matter yield over minus P. Also, co-inoculation with Rhizobia and Mycorrhiza gave a statistically similar dry matter yield to where mineral N and P were applied. It is concluded that co-inoculation with Rhizobia and Mycorrhiza can be employed as possible alternative to the much more expensive inorganic fertilizers.
Key words: Co-inoculation, Dry matter yields, Mycorrhiza, Rhizobia and Yield components

Introduction
Grain legumes have the ability to fix N from the atmosphere through a symbiosis with soil bacteria known as rhizobia. Symbiotic relationship between rhizobia and legumes is responsible for contributing the largest amounts of fixed nitrogen to agriculture. Estimates indicate that legumes can fix up to 200 kg N ha^{-1} $year^{-1}$ under optimal field conditions (Giller, 2001). Hence, Symbiotic N_2 fixation is considered as economically viable means of supplying N to crops. On the other hand, Mycorrhizas are common in most terrestrial ecosystems and form relationships with the majority of plant families (Smith and Read, 2008). The beneficial effects of Mycorrhizal symbiotic association on the growth of plants are well known (Okon *et al*., 2010). They help in water regulation of plants by extending their hyphae towards the available moisture zone for continuous water and nutrient absorption and translocating them to plants (Arumugam *et al*., 2010).

Soybean, a grain legume, hosts rhizobia and mycorrhiza at the same time thus benefiting one another. This association involving legumes, rhizobia and mycorrhiza is known as tripartite symbiosis. The association with rhizobia is involved in the fixation of atmospheric N while the association with mycorrhiza modifies the ability of the plant to take up P (Lodwig *et al*., 2003). The dual inoculation with rhizobia and mycorrhizas causes synergistic beneficial effects and they act as biofertilizers for crops (Xavier and Germida, 2002). They play a key role in natural ecosystems and influence plant productivity, plant nutrition and plant community structure. In many experiments dual inoculation with both symbionts resulted in higher plant biomass (Xavier and Germida, 2012). The tripartite symbiotic associations were reported to be more effective than rhizobial or mycorrhizal inoculation alone in respect to yields of plants (Saxena *et al.,* 1997). This experiment was therefore carried out to examine the effect of dual inoculation with rhizobia and mycorrhiza on yield components of soybean in northern guinea savanna of Nigeria.

Materials and Methods

The experiment was conducted in a Screenhouse at the Department of Soil Science, Institute for Agricultural Research (IAR) station Samaru (N11°10´31.3´´, E007°36´38.9´ and 704 m above sea level). A bulk soil was collected from IAR experimental field, air-dried, crushed and sieved through 2mm sieve mesh. The soil was then put into 3 L pot and nutrient solutions were applied. The set up was left for 24 hours to equilibrate. The physical and chemical analyses were determined using standard methods as reported in Okalebo *et al*., (2002). Inoculation with rhizobia was done before planting. Here, seeds were surface sterilized, mixed with the rhizobial inoculant and then planted. The Mycorrhizal inoculation was done in layers in the pot. Here, pots with mycorrhizal treatment were inoculated with mycorrhiza in layers. The experiment was laid out in completely randomized design (CRD). There were 9 treatments replicated 3 times. The treatments consisted of 3 levels of N (+N, Rhizobia and –N), 3 levels P (+P, Mycorrhiza and –P) and 3 levels of N and P combinations (+N +P, Rhizobia + Mycorrhiza and –N –P). Routine management such as irrigation and weeding were done when necessary. Harvesting was done at 8 weeks after planting when the plants had attained flowering stage. The shoot was cut off from the base and the root was carefully removed from soil by passing them through running tap water. The root length was determined using meter rule. Both the shoots and roots were put in separate clean paper bag and then oven dried at 60ºC until constant weight. The root and shoot dry weights were taken and dry matter yield determined. Data collected were subjected to ANOVA using GLM procedure. Where significant F values between the means were recorded, the Tukey honesty significant difference (HSD) was used to separate the means.

Results and Discussion

The physical and chemical properties of the experimental soil showed that the soil is loamy in nature having textural classes fairly distributed (sand = 50%, silt = 26% and clay =20%). The soil is acidic in nature (pH = 4.65), which depicts the nature of the soils in the tropics. Also, the organic carbon content of the soil is low (6.30 gkg^{-1}) while the available P (16.24 gkg^{-1}) of the soil falls within moderate class level. The total nitrogen is also low (1.1 gkg^{-1}). In general it can be said the soil is a medium in fertility.

Effect of Co-application with Rhizobia and Mycorrhiza on yield components of soybean

Analysis of the root dry weight yield showed that there was significant difference between the treatments (Table 1). Highest root dry weight was recorded by inoculation with Mycorrhiza. This was statistically higher than the controls (Minus P and Minus N). The percentage difference between the inoculated soybean with mycorrhiza and controls is 72%. Analysis of shoot dry weight also revealed significant difference (p<0.05) between the treatments (Table 1). Here, highest shoot dry weight was recorded by plus P followed Mycorrhiza and then N + P treatment. These were statistically higher than plus N, Minus N, Rhizobia, minus P and minus N minus P treatments. Similar trend was also observed in the analysis of root length where the highest root length was recorded by plus P treatment. This was statistically higher than minus N and minus N minus P treatments with magnitude of 45% and 46% respectively (Table 1).

Table 1: Mean values of yield components as affected by co-inoculation of Rhizobia and Mycorrhiza

Treatment	Root Dry Weight (mg)	Shoot Dry Weight (mg)	Root length (mm)
Plus N	410ab	1980bc	195b
Rhizobia	350ab	1600c	182ab
Minus N	430a	1830bc	164b
Plus P	390ab	2870a	239.2a
Mycorrhiza	430a	2810a	219.3ab
Minus P	250b	1650bc	187.2ab
N + P	330ab	2800a	202.3ab
Rhizobia + Mycorrhiza	300ab	2230ab	215.7ab
Minus N Minus P	320ab	1970bc	163.7b
SE	80	310	32.8

Means with the same letters in column are not statistically different by Tukey (HSD)

Effect of Co-application with Rhizobia and Mycorrhiza on dry matter yield of soybean

Analysis of the effect dual inoculation and N and P fertilization showed that there was significant variation in dry matter yield between the different treatments (Fig 1). It showed that highest dry matter yield was recorded by the treatment Plus P followed by the treatment Mycorrhiza and these recorded a statistically higher than the treatment Rhizobia and Minus P. The difference between the treatment Plus P and treatment Minus P in terms of dry matter yield was 67%. The plus P treatment was 68% higher than treatment rhizobia. The treatment Mycorrhiza was also 69% higher than Minus P and 66% higher than Rhizobia in dry matter yield.

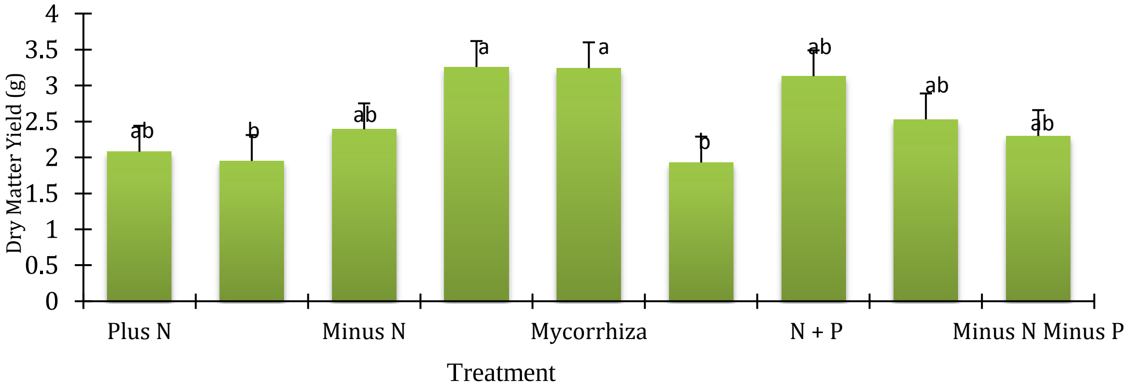

Fig 1: Effect of Co-application with Rhizobia and Mycorrhiza on dry matter yield

The current study shows that co-inoculation with rhizobia and Mycorrhiza significantly increased yield components of soybean under low P and/or low N conditions as indicated by increased root and shoot dry weights as well as the total dry mater yield. In particular, inoculation with Mycorrhiza gave the highest increment in the yield components of the soybean under the same condition. This could be attributed to the increased nutrient absorption capacity by the Mycorrhiza via their hyphal network. This is possible because the hyphal networks, which serve as extension of the plant roots, explore soil volume where plant roots cannot reach and translocate it to the plants. It is reported that inoculation with Mycorrhiza improves nutrient absorption and translocating from soil to plants (Arumugam *et al*., 2010). The resultant increase in the plant growth with application of mineral nutrient may be attributed to response to increased soil nutrient such as P. Phosphorus supply in soil has been noted for several legumes including soybean as reported by Sanginga *et al*., (1994). High dry matter yield observed in the treatment where P was applied was because of the availability of soil P to the plants in question. Phosphorus availability has been widely reported to have a significant positive effect on dry biomass production (Marschner *et al*., 1995). The statistically similar dry matter yield of soybean between N+ P treatments and Rhizobia + Mycorrhiza indicated an impact of the co-inoculation on soybean. Study by Ames *et al.* (1991) has indicated that interaction between Rhizobium and Mycorrhiza significantly affected legumes' growth. The treatment with single inoculation with rhizobia however recorded a significantly lower dry matter than other treatment such as the Mycorrhiza and P application. It is possible that most of the rhizobial cells died during storage before they were put to use. This could result due to high temperature normally experienced in the tropics. The success of rhizobial inoculants is dependent on the number of viable bacteria available to participate in the infection process at the point of use (Catroux *et al*., 2001).

Conclusion

The study showed that the Co-inoculation with Rhizobia and Mycorrhiza increased the yield components of soybean and can give similar yield to where the inorganic N and P fertilizers were applied. This is an indication that the co-inoculation can be employed as possible alternative to the much more expensive and potentially deleterious inorganic fertilizers. Hence research efforts should be focused on quality assessment of inoculants production to identify elite strains of both rhizobia and mycorrhiza that would compete with the inorganic fertilizer.

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Growth and Nutrient Uptake of Coffee Intercrop with Oil Palm in Specific Geometries in Nigeria

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Abstract
Field studies were conducted at Cocoa Research Institute of Nigeria (CRIN) Headquarters, Idi – Ayunre, Ibadan Latitude 7⁰25'N and Longitude 3⁰25'E Oyo State and CRIN Substation at Uhonmora, Latitude 6⁰50′ N and Longitude 5⁰50′ E Edo State, to determine the nutrient uptake of coffee plants intercropped with oil palm. The trial had three treatments comprising coffee sole (control), coffee with oil palm (Hollow square) arrangement and coffee with oil palm (Avenue) planting. Equal area of land was used for coffee in all the treatments. Coffee and oil palm were planted at a spacing of 3.0m x 3.0m and 9.0m x 9.0m triangular respectively. The experiment was a Randomized Complete Block Design (RCBD) replicated three times. The least nutrient uptake by coffee in the two locations was in the control (Coffee sole) while the highest was in coffee with oil palm (Hollow Square). This could be due to a better arrangement with better shade regime of oil palm reduced root competition and nutrient build up in Hollow Square arrangement. There were significant differences ($P < 0.05$) among the treatments with hollow square arrangement > Avenue > control
Keywords: Nutrient uptake, Coffee, Oil palm and Intercrop

Introduction
One of the management problems associated with coffee production in Nigeria is how to maintain the level of soil nutrients status during field establishment as virgin soil is no more readily available. A review of available literature on mix-cropping in the tropics has been carried out (Adeyemi, 1997; Onwubuya, *et al.*, 1981; Ofoli and Lucas, 1988; Okpala-Jose and Lucas, 1988; Sparnaaji, 1987; Famaye, 2000). Traditionally, farming system in the tropics is generally a mixed cropping as mono cropping is rare. The benefits from intercropping or mixed cropping include insurance against complete crop failure through diversification; keeping the farmer busy all the time and allowing better use of his time; improving land use efficiency and the income accruing to the farmer as well as increase in profit per unit area of land. The advantage of mix-cropping coffee with oil palm is that it enhances the efficient utilization of the arable land by increasing the total output from both crops and ultimately the income accruing to the farmer. However, the report on nutrient uptake by coffee intercropping is scanty. The objective of this study therefore was to evaluate the nutrient uptake of coffee intercropping with oil palm in avenue and Hollow Square arrangements.

Materials and Methods
The experiment was carried out in two locations in Cocoa Research Institute of Nigeria (CRIN). The locations are Idi – Ayunre, Ibadan Latitude 7⁰25'N; Longitude 3⁰25'E and Uhonmora, Latitude 6⁰ 50'N; Longitude 5⁰ 50'E. The soil of Idi – ayunre and Uhonmora are alfisol and ultisol respectively. These locations are rain forest and derived savanna respectively. The coffee (*Coffea canephora*) seed was obtained from CRIN nursery in both locations. Oil palm seedlings (Tenera variety) were obtained from National Institute of Oil palm Research (NIFOR) Benin City, Edo State. Plantain suckers were obtained from CRIN as shade for coffee seedlings at establishment. The experiment had three treatments, (a) Coffee Sole (control), (b) coffee/oil palm (Avenue arrangement) and (c) coffee/oil palm (Hollow Square arrangement). The experimental design was Randomized Complete Block Design (RCBD) replicated three times. Parameters considered

were physical and chemical properties of the soil at the beginning of the experiment as well as plant height, stem girth and leaf area. Coffee seedlings were also uprooted on treatment basis, washed and weighed. They were then oven dried to constant weight at $70^{0}C$. The dried plants were milled, analyzed for N, P, K and Ca. The uptake was calculated using NC= Yield x nutrient content of plant (Obatolu, 1991). The results obtained were subjected to statistical analysis of variance and LSD was used to separate the significant means.

Results and Discussion

Table 1 shows the result of the soil physical and chemical properties of the study locations. The soil pH of 6.2 and 5.2 for Idi – Ayunre and Uhonmora respectively were appropriate for coffee production as earlier reported by Famaye (2005). The result on plant height, stem diameter and leaf area are shown in Table 2, 3 and 4 respectively. In the first 3 months of transplanting the coffee morphological parameters of all the treatments in both locations were not significantly different; 6 months thereafter, there were little difference but not significant at $P \leq 0.05$. As from 9 months there were significant difference $P \leq 0.05$ in the intercrops. The same trend was followed through to 24 months after transplanting to the field. Coffee in Hollow Square arrangement gave the highest values closely followed by the avenue arrangement. These results showed that shading from oil palm under which coffee were planted in the Hollow Square provided optimal light intensity adequate for better growth than the control in full sunshine and avenue arrangement. The better performance of Hollow Square treatment over Avenue might be due to the shading effects of oil palm trees on coffee as more coffee trees were more shaded by the oil palm in the Avenue treatment thus creating more competition between them for light. This corroborates the earlier work done (Famaye, 2000). The beneficial effect on good growth of coffee was earlier reported for other tree crops like cocoa when plantain was used as shade (Opeke, 1982). The better performance of Hollow Square over control treatment indicates the efficiency of land use on mix-cropping over sole cropping as earlier reported by Onwubuya, *et al.* (1981); Sparriaaji (1987); Aya and Lucas (1988); Coste (1992); Adeyemi (1997). Nutrient uptake of coffee in the first and second years, are shown in Table 5. The highest N uptake was recorded in coffee (Hollow Square) and closely followed by Avenue in the two locations. The amount of nutrient uptake generally increased with the age of coffee. The N uptake is higher in Idi-Ayunre than Uhonmora. This might be as a result of differences in soil classes (alfisol in Ibadan; ultisol in Uhonmora). There was no significant difference ($P<0.05$) between the P uptake in the two locations within the first year while there was significant difference in the second year with the coffee (Hollow Square) giving the highest value. K uptake was significantly higher in the Hollow than in the Avenue with the lowest in the control in the first year while the control was highest in Idi-Ayunre in the second year. Ca uptake showed the same trend recorded for N uptake for Idi-Ayunre and Uhonmora with control being the least and Hollow Square the highest. The sole coffee was not able to satisfy its nutrient needs due to leaching of important nutrient elements. Nigeria farmers hardly use fertilizers mostly due to its scarcity, high cost of the few available ones and generally the poor economic conditions of the farmers. The nutrient uptake in coffee in Hollow Square arrangement that was significantly higher than the control as well as Avenue might was due to nutrient build up as a result of better shading from the oil palm trees which reduced evapotranspiration and enhanced microbial activities (Famaye and Adejobi, 2015; Famaye *et al*., 2014; Famaye *et al*., 2013). Besides, the fibrous root system of oil palm could have enhanced nutrient retention within coffee rooting zone thereby making nutrients available unlike in sole.

Table 1: Soil physical and chemical properties of the experimental sites at the beginning of the experiment

Soil properties	Idi – Ayunre	Uhonmora
pH(H_2O)	6.2	5.2
% Organic carbon	0.75	0.84
% Total nitrogen	0.07	0.09
Available P (mg/kg soil)	7.40	7.15
Exchangeable K (cmol/kg soil)	0.42	0.05
Exchangeable Ca (cmol/kg soil)	2.45	2.65
Exchangeable Mg (cmol/kg soil)	0.03	0.04
Exchangeable Na (cmol/kg soil)	0.01	0.02
% Sand	81.60	78.8
% Silt	8.40	9.2
% Clay	10.00	12.00
Soil classification	Alfisol	Ultisol

Table 2: Plant height (cm) of coffee intercropped with oil palm in Avenue and Hollow square arrangements

Locations	Treatments	Months after transplanting							
		3	6	9	12	15	18	21	24
Idi – Ayunre	Coffee sole (control)	20.10	30.00	39.00	43.10	47.20	49.70	58.30	70.7
	Coffee (Avenue)	19.10	27.00	43.40	45.20	49.10	50.90	60.00	75.30
	Coffee (Hollow square)	19.70	27.40	43.40	47.00	50.20	53.90	64.20	81.00
	Means	20.00	28.10	42.10	45.10	48.50	51.70	60.80	75.70
	LSD (P ≤ 0.05)	8.99	4.48	9.95	2.24	3.01	7.98	7.78	12.02
Uhonmora	Coffee sole (control)	15.70	22.00	30.10	35.60	39.90	42.30	47.40	52.50
	Coffee (Avenue)	16.3	22.1	32.00	38.5	40.80	44.60	50.10	57.20
	Coffee (Hollow square)	15.50	24.30	38.10	42.70	45.50	50.20	57.50	63.40
	Means	15.8	22.8	33.40	38.9	42.10	45.70	51.70	57.60
	LSD (P ≤ 0.05)	1.03	3.23	10.38	8.86	7.47	10.07	12.98	18.31

Table 3: Stem Diameter (cm) of coffee intercropped with oil palm in Avenue and Hollow square arrangements

Locations	Treatments	Months after transplanting							
		3	6	9	12	15	18	21	24
Idi – Ayunre	Coffee sole (control)	0.22	0.50	0.70	0.75	0.76	0.95	1.03	1.15
	Coffee (Avenue)	0.21	0.44	0.61	0.71	0.79	1.00	1.13	1.20
	Coffee (Hollow square)	0.30	0.44	0.70	0.75	0.76	0.95	1.03	1.15
	Means	0.24	0.46	0.67	0.74	0.79	0.99	1.10	1.20
	LSD (P ≤ 0.05)	0.12	0.05	0.13	0.07	0.06	0.02	0.16	0.12
Uhonmora	Coffee sole (control)	0.21	0.33	0.60	0.63	0.65	0.72	0.82	0.90
	Coffee (Avenue)	0.21	0.34	0.69	0.65	0.68	0.76	0.83	1.00
	Coffee (Hollow square)	0.25	0.36	0.65	0.70	0.75	0.80	0.94	1.05
	Means	0.22	0.34	0.62	0.66	0.69	0.76	0.98	0.98
	LSD (P ≤ 0.05)	0.06	0.04	0.07	0.09	0.13	0.10	0.10	0.19

Table 4: Leaf area (cm^2) of coffee intercropped with oil palm in Avenue and Hollow square arrangements

Location	Treatments	Months after transplanting							
		3	6	9	12	15	18	21	24
Idi – Ayunre	Coffee sole (control)	74.10	82.00	86.40	105.20	116.00	119.70	157.10	140.20
	Coffee (Avenue)	73.00	82.10	87.80	110.30	121.50	130.30	142.60	149.00
	Coffee (Hollow square)	79.00	87.70	93.50	117.90	130.30	141.50	132.50	164.10
	Means	75.40	83.9	89.20	111.10	122.60	130.50	144.00	151.10
	LSD (P ≤ 0.05)	7.93	8.10	9.34	15.87	17.91	27.60	30.81	30.01
Uhonmora	Coffee sole (control)	64.20	73.6	90.30	99.50	113.2	120.30	128.50	140.30
	Coffee (Avenue)	64.10	75.50	97.80	105.30	119.00	128.10	134.70	148.70
	Coffee (Hollow square)	64.50	78.00	105.10	116.40	125.30	137.60	145.40	159.10
	Means	64.3	75.70	97.70	107.10	119.20	128.70	136.20	149.40
	LSD (P ≤ 0.05)	0.52	4.48	18.37	21.32	15.02	21.51	27.22	23.38

Table 5: Nutrient uptake (g/plant) of coffee intercropped with oil palm in Avenue and Hollow square arrangements

Locations	Treatments	Year 1				Year 2			
		N	P	K	Ca	N	P	K	Ca
Idi – Ayunre	Coffee sole (control)	0.50	0.41	2.46	2.51	0.71	0.52	2.46	2.63
	Coffee (Avenue)	0.51	0.40	2.68	2.60	0.92	0.63	1.94	2.68
	Coffee (Hollow Square)	0.56	0.41	2.89	2.75	0.97	0.75	1.53	2.82
	Means	0.52	0.41	2.68	2.62	0.87	0.63	1.98	2.71
	LSD (P ≤ 0.05)	0.08	0.01	0.53	0.30	0.08	0.29	0.27	0.24
Uhonmora	Coffee sole (control)	0.30	0.43	3.00	2.37	0.82	0.47	3.45	2.51
	Coffee (Avenue)	0.40	0.43	3.31	2.42	0.87	0.45	3.61	2.73
	Coffee (Hollow Square)	0.42	0.44	3.39	2.51	0.93	0.46	3.70	2.95
	Means	0.37	0.43	3.23	2.43	0.87	0.46	3.59	2.73
	LSD (P ≤ 0.05)	0.16	0.01	0.51	0.18	0.14	0.02	0.31	0.13

Conclusion

The Hollow Square treatment of growing coffee with oil palm was found superior in nutrient uptake to the other treatments of Avenue and control. This could be recommended to the farmers instead of sole planting or Avenue arrangement.

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Mycorrhizal (*Glomus hoi*) effect on resistance of rice to *Magnaporthe grisea*

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Abstract

The study evaluated the effect of interaction between susceptible rice accessions and mycorrhiza (Glomus hoi) on the resistance of rice accessions and some growth parameters of rice. Ten susceptible rice accessions were planted at the screenhouse in randomised complete block design. Each accession was planted in a bucket inoculated with 60 g of mycorrhizal inoculum and replicated three times and also another 3 replications without mycorrhizal inoculum. The replications were spaced by 0.5 m. The data collected included plant height, number of tillers and leaf blast scores. The data were subjected to Analysis of Variance (ANOVA) and means were separated using LSD at 5% level of probability. The result revealed that there were significant differences between rice accessions inoculated with Glomus hoi and those that were not inoculated. The rice accessions with relatively high value of RFMD index (>25) had leaf blast severity scores ranging from 0 (highly resistant) to 3 (moderately resistant). The study concluded that the association between Glomus hoi and rice roots significantly improves the resistance of rice to blast disease.

Introduction

Rice *(Oryza* spp) is the most important staple food in the world today (FAO, 2014). It has become part of everyday diet of many homes. Currently the world population eating rice is about three billion people which is about half of the world population (IRRI 2009). Rice production is however faced by some challenges which include inadequate input, insufficient number of extension agents, poor acceptance of new innovation on the part of the farmers, climatic changes, pests and poor irrigation system (Singh *et al*., 2008). Sonia and Gopalakrishna (2005) reported that rice blast disease is one of the main pathological threats to rice crop globally. It is a fungal disease caused by *Magnaporthe grisea*. The pathogen attacks the leaves, causing leaf blast during the vegetative stage of growth, or neck, nodes and panicle branches during the reproductive stage (Bonman *et al*., 2012). Blast disease was first reported in Asia, centuries ago and is now present in over 85 countries. Blast propagules can survive on seeds and can easily be moved across borders if safety checks are not in place. Although successful chemical control measures have evolved, these are too expensive and cumbersome to apply, hence, host resistance is given priority in disease control strategy. It is considered as a no-cost technology, especially for the poor farmers and also an important component of the eco-friendly technique of integrated disease management program. However, neither chemical nor breeding for resistance provides absolute control, due to the pathogen's ability to rapidly adapt. Hence, crops remain vulnerable (Sere *et al*., 2011). Breeders have spent years looking for resistant varieties of rice, they have not only collected many traditional rice varieties that are resistant to blast, but have also identified a number of rice genes that they believe are responsible for the resistance. The use of resistant varieties has been proven to be the most effective and economical way of controlling rice blast disease (Xueyan *et al*., 2014). However, failures of resistances are observed under different field conditions, as the susceptibility of rice varieties to blast pathogen differs depending on the locality, diversity of the pathogen and the resistant gene carried by the different species of rice plant (Xueyan *et al*., 2014). Early studies on mycorrhiza, which is an ubiquitous soil inhabitant forming symbiosis with most naturally growing terrestrial (Gai *et al.,* 2006) and aquatic (Javaid *et al*., 2007) plants, showed an improved growth and/or yield of mycorrhizal plants, first attributed exclusively to the improved nutritional status of the plant (Linderman, 2006). Later, several authors reported a higher tolerance of mycorrhizal plants to abiotic stresses, such as drought, nutrient deficiency or presence of heavy metals (Miransari, 2010; Smith *et al*., 2010) and also higher resistance to diseases (Salami, 1999). There is little information on the influence of mycorrhiza on the resistance of rice to blast disease. The objective of this study was to evaluate the effect of interaction between susceptible rice accessions and mycorrhiza(*Glomus hoi*) on the resistance of rice accessions to blast disease

Methodology

Thirty rice accessions were obtained from National Cereals Research Institute, Badeggi, Nigeria screened for resistance against blast pathogen out of which ten susceptible accessions were selected and used for this study (Table 1). This study was carried out in the screenhouse of Faculty of Agriculture, Obafemi Awolowo University, Ile-Ife in 2016. The experiment was laid out in a Randomized complete block design (RCBD) with each accession planted in a bucket inoculated with 60 g of mycorrhizal inoculum and replicated three times and another 3 replications without mycorrhizal inoculum. Two replications were spaced by 0.5 m. Infected leaves were collected from infected rice field, blended into particles and spread along the ten rice accessions in the screenhouse, two weeks after emergence.

Table 1: Rice accessions evaluated at the Screenhouse

S/N	ACCESSIONS
1	C103TTP
2	C039
3	IRBLTA2-Pi
4	ARICA 4
5	MARATELLI
6	ARICA 5
7	IRBLK-KA
8	KUSABUE
9	ARICA 1
10	SHA TIAO-TSAO

Each plant was scored for leaf and neck blast using Standard Evaluation System (Tables 2 and 3). Number of leaves, plant height, number of tillers, stem girth, disease incidence, disease severity and the relative field mycorrhizal dependency (RFMD) index (Plenchette *et al*., 1983) was also recorded.

$$\%RFMD = \underline{\text{Dry weight of mycorrhizal plant – Dry weight of non-mycorrhizal plant}} \times 100$$

Data collected were subjected to statistical analysis SAS version 9.13. Analysis of variance (ANOVA) was carried out and significant means were separated using LSD at 0.05 level of probability. Correlation analysis was carried out between leaf blast severity, leaf blast incidence, neck blast severity, number of leaves, number of tillers, plant height, stem girth and relative field mycorrhizal dependency (RFMD) index. Regression analysis was also carried out on RFMD index and Leaf blast severity.

Results and Discussion

There were significant differences between the mean values of the leaf blast severity for the rice accessions with mycorrhizal inoculum (*Glomus hoi*) and those without mycorrhizal inoculum as from 49 DAP (Table 2). The lowest leaf blast severity for both inoculated and uninoculated rice accessions was at 42 days after planting and this increased gradually from 42 days after planting, having the highest leave blast severity score at 84 DAP (Table 2). The level of disease severity was consistently higher for rice accessions without *G. hoi* in comparison with those inoculated with *G. hoi* (Table 2).

Table 2: Effect of mycorrhizal inoculation on leaf blast severity of ten rice accessions evaluated in the Screenhouse

Parameter	42	49	56	63	70	77	84
No_myco	0.20	0.87	1.40	2.30	3.00	3.80	4.53
Myco	0.13	0.33	0.90	1.10	1.87	2.83	3.43
$LSD_{(0.05)}$	0.90	0.21	0.21	0.25	0.28	0.44	0.37

(Mean values at 0.05 level of probability), 42, 49, 56, 63, 70, 77 and 84 --- Days after planting

Significant differences in the mean values of the leaf blast incidence for the rice accessions with mycorrhizal inoculation and those without mycorrhizal inoculation were obtained as from 49 days after planting (Table 3). The lowest leaf blast severity for both inoculated and uninoculated rice accessions was at 42 days after planting, however this increased gradually and attained the highest leave blast severity at 84 days after planting. The level of disease severity was consistently higher for rice accessions without *G. hoi* in comparison with those inoculated with *G. hoi* (Table 3).

Table 3: The effect of mycorrhizal inoculation on leaf blast incidence of the ten rice accessions evaluated in the Screenhouse

Parameter	42	49	56	63	70	77	84
No myco	2.23	11.21	21.65	29.31	36.19	44.81	53.04
Myco	2.27	8.78	12.76	17.46	27.82	38.75	43.78
$LSD_{(0.05)}$	0.99	1.24	2.55	1.72	2.46	1.81	2.93

(Mean values at 0.05 level of probability), 42, 49, 56, 63, 70, 77 and 84 --- Days after planting

The mean values of RFMD index for accessions with marginal RFMD index (< 25%) were significantly different from the other accessions that had moderate RFMD index (25-50%), with accession 10 having the highest value of RFMD index (43.36) while accession 3 had the lowest value of RFMD index (14.72) (Table 4).

Table 4: Relative field mycorrhizal dependency index of the ten rice accessions evaluated in the Screenhouse

Accessions	RFMD_I (%)	LBS
1	32.46	3
2	34.63	3
3	14.72	7
4	35.92	3
5	18.00	5
6	29.52	3
7	41.31	3
8	39.32	1
9	15.72	5
10	43.36	1
$LSD_{(0.05)}$	7.34	

RFMD_I = Relative field mycorrhizal dependency index. LBS = Leaf blast severity

There was high significant positive correlation between leaf blast severity and leaf blast incidence (Table 5). There was also a significant positive correlation between leaf blast incidence and neck blast severity (Table 5). There was a significant negative correlation between leaf blast severity and RFMD index (Table 5). Also, there was highly significant negative correlation between leaf blast incidence and RFMD index. There was no linear relationship among the other parameters correlated (Table 5).

Table 5: Spearman's correlation coefficient of growth parameters, disease incidence, disease severity and relative field mycorrhizal dependency index

	LBS	LBI	NBS	NL	NT	PH	SG	RFMD_I
LBS		0.81**	0.47ns	-0.31ns	0.01ns	0.07ns	-0.66ns	-0.67*
LBI			0.71*	-0.48ns	-030ns	-0.30ns	-0.49ns	-0.70**
NBS				-0.32ns	-0.31ns	-0.54ns	-0.49ns	0.38ns
NL					0.51ns	0.07ns	0.35ns	0.33ns
NT						0.45ns	-0.15ns	0.06ns
PH							-0.35ns	0.26ns
SG								0.31ns
RFMD_I								

*,** significantly different at 0.05 and 0.01 levels of significant. ns--- not significant.
LBS = Leaf blast severity, LBI = Leaf blast incidence, NBS = Neck blast severity, NL = Number of leaves
NT = Number of tillers, PH = Plant height, SG = Stem girth, RFMD_I = Relative field mycorrhizal dependency index

Higher resistance of mycorrhizal plant to a wide range of below-ground attackers such as soil-borne nematodes, fungal, root chewing insects, fungal and bacterial pathogens was reported by Sabine *et al*. (2012). But in the last decade, induced resistance by mycorrhizal association against shoot pathogens was reported by koricheva *et al*. (2009). The accessions used at the screenhouse had leaf blast severity score ranging from 0 (highly resistant) to 7 (susceptible), whereas the same set of accessions had leaf blast severity scores 9 (highly susceptible) on the field. This implies that the mycorrhizal association between *Glomus hoi* and the roots of the rice accessions was able to enhance the innate resistance of the plant thus reducing the magnitude of leaf blast severity in most of these susceptible accessions to an appreciable level. This supported the findings of Effmert *et al*. (2012) who reported that protective effect observed in mycorrhizal plant association does not only confer growth benefits to plants, but also influence interactions with other organisms including pathogens and beneficial microbes. The rice accessions responded in diverse ways to the presence of *G. hoi* which was indicated by the differences in leaf blast scores and relative field mycorrhizal dependency (RFMD) index. The rice accessions with relatively high value of RFMD index (>25) had leaf blast severity scores ranging from 0 (highly resistant) to 3 (moderately resistant). This might be as a result of the dependency of the plant on the nutrient uptake from the soil which was enhanced by the mycorrhizal association between the plant root and the *G. hoi* thereby improving the resistance of the accessions. The correlation analysis between RFMD index and Leaf blast severity/ incidence showed that there was an inverse relationship between the parameters as revealed by the negative correlation coefficient value. This implied that the higher the RFMD index, the lower the level of severity and incidence of leaf blast disease. This is an indication that *Glomus hoi* conferred protective properties on the rice accessions inoculated with *G. hoi*. This conforms to the observation of Liu *et al*. (2007) who reported that the use of mycorrhizal inoculum in crop production increased the plant resistance against biotic and abiotic stresses.

Conclusion

This study has clearly shown us that the association between *Glomus hoi* and rice roots significantly improves the resistance of rice to blast disease.

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Tuber Yield Evaluation of Three Ware-Yam Cultivars in Lowland Humid Tropics, Umudike, Nigeria

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Abstract
A two-year pot-field experiment was carried out to evaluate the yield performance of three ware-yam cultivars (Alumaco, Nwopoko, Hebamkwase) at National Root Crops Research Institute, Umudike, Abia State, Nigeria (05° 29´ N, 07° 32´ E,122 metres a. s. l.) in 2014 and 2015 cropping seasons. The pot experiment was laid out in a completely randomized design with three replications. The results indicated that all the tested variables were significant in both years except number of seed yams/plot in 2014 cropping season. Alumaco ware-yam cultivar gave the highest fresh tuber yield compared with the other cultivars studied and exhibited the least percentage of nematode incidence in both years. The mean sequence of tuber yield of the ware-yam cultivars in the order: Alumaco > Nwopoko > Hebamkwase in 2014 and 2015 cropping seasons. Fresh tuber yield (t ha^{-1}) indicated highly significant ($P \leq 0.01$) and positive correlation with all the yield attributes, especially weight of tubers/plot and bulking rate in both years with correlation coefficients (r) ranging from 0.55 to 1.00 (2014) and 0.61 to 1.00 (2015). Also, the regression analysis showed a poly-linear and positive relationship between nematode incidence and fresh tuber yield of ware-yam in both years. Alumaco ware-yam cultivar was the highest yielder, hence adjudged to be better endowed genetically to be recommended to farmers within the agro-ecological zone of the study area.

Keywords: Dioscorea rotundata, ware-yam, nematode and tuber yield

Introduction
The field crop Yam (*Dioscorea* spp), which produces an edible subterranean or aerial tubers that are greatly of food and economic value is an annual or perennial crop. It is a veritable source of carbohydrate with about 50 to 80 per cent starch or dry matter yield (Shanthakumari *et al*., 2008; IITA, 2009) and about 1 to 2 per cent dietary protein, which is high compared with other tropical root crops (Udensi *et al*., 2008; Arinathan *et al*., 2009). Yam is a strong food security tuber crop in most Sub-Sahara African countries (Ikeorgu, 2003; Behera *et al*., 2009; Ugwu, 2009; IITA 2009) because it is a source of good dietary energy for human consumption.One of the most cultivated and accepted species of yam in Nigeria is *Discorea rotundata* (white yam) and its production is constrained by many challenges such as high cost of production and poor yield. The edible tubers are normally used in its propagation, hence, production cost is usually high, which therefore constitutes a strong discouraging factor in production Orkwor and Asiedu (1998). More so, the crop is plagued by nematode amongst other pests' attack singly or in combination. Though studies have shown that yam tubers naturally have a periderm, such that micro-organisms cannot penetrate, it is easily scared by nematodes, rodents and man during weeding and harvesting leading to microbial attack on the tuber crop (Marfo *et al*., 1998; Kambaska *et al*., 2009). These constrains, lead to recorded poor tuber yields from cultivated yams across the agro-ecosystem. More so, there is little information on the yield performance of some improved yam cultivars in the low land tropics of Umudike, southeast Nigeria. The aim of the study therefore was to evaluate the yield performance of three improved ware-yam cultivars under rain-fed Umudike agro-ecological conditions.

Materials and Methods

A rain-fed pot experiment was conducted at the yam programme, National Root Crops Research Institute, Umudike, Nigeria (latitude 05° 28′ N, longitude 07° 29′ E, and altitude 122 m above sea level) in the humid tropics of south eastern Nigeria. The location is characterized by a mean annual rainfall of 1,800 to 2,200 mm, which begins in April, peaks in July with a brief dry period in August and ends towards October and early November. The soil of the experimental site is sandy loam (Ultisol) belonging to the order ultisol and classified as Paleulstult. The treatments comprised three cultivars ware-yam (*Nwopoko, Hembamkwase* and *Alumaco*). The experimental treatments were laid out in a completely randomized design and there were three replications.
Clean seed yam tubers of the cultivars were planted in perforated *baggco* pots filled with 15 kg sieved top soil and kept in the field under rain-fed conditions (4th and 7th March, 2014 and 2015 cropping seasons, respectively). The sprouted setts were checked early mornings three times weekly until the vines were properly established. Staking of the vines was done using the trellis method to ensure even distribution of the leaves for better interception of sun light and aeration.
The experimental plots were kept clean by hand picking of the weeds as they appear in the pots while a compound fertilizer (NPK 15:15:15) was applied at the rate of 400 kg ha^{-1} at 8 Weeks after planting. The growing main and lateral vines were periodically and systematically trained on the stakes during the vegetative period. At harvest, data such as number of seed yams $plot^{-1}$, number of ware yam tubers $plot^{-1}$, fresh tuber weight $plot^{-1}$, and fresh tuber yield (t ha^{-1}) were collected. Bulking rate was calculated as the ratio of tuber yield to the duration of tuberization of the ware yam while nematode incidence incidence recorded was calculated thus: [Incidence (%) = Number of tubers infected / Total number of plants on the plot]. The data collected were subjected to analysis of variance procedures using the statistical software Genstat Discovery Edition 4 (Genstat, 2014) while treatment mean comparisons were achieved by following the procedure outlined by Obi (2002) using Fisher's method where a probability level ≤0.05 was considered significant. Correlation was performed using SPSS 17 for windows soft-ware.

Results and Discussion

Analysis of variance (Table 1) indicated that except number of seed yams/plot in 2014, the other variants [number of ware-yams $plot^{-1}$, fresh tuber yield $plot^{-1}$, fresh tuber yield (Mt ha^{-1}) and bulking rate (kg^{-1} day^{-1} ha^{-1})] exhibited different degrees of significance in both years. In 2015, *Alumaco* significantly ($P<0.05$) gave the highest number of seed yams $plot^{-1}$compared to the other cultivars. While in both cropping seasons, it gave the highest number of ware-yams $plot^{-1}$ and weightiest fresh tuber yield $plot^{-1}$ and per hectare. Also, in the two cropping seasons, *Alumaco* yam cultivar exhibited the highest bulking rate, which was higher by 55.8 and 37.3 per cent relative to *Nwopoko* and *Hebamkwase*, respectively (2014) and 56.3 and 22.8 per cent relative to *Nwopoko* and *Hebamkwase*, respectively (2015) cropping season. The mean sequence of tuber yield of the ware-yam cultivars was in the order: *Alumaco* > *Nwopoko* > *Hebamkwase* in both years. The findings from the study corroborate similar works by Balogun *et al*. (2004), Law-Ogbomo (2007) as well as Nwosu and Okoli (2010) in their various studies on white ware-yam in different agro-ecological zones across Nigeria.Nematode incidence on the ware yam cultivars was significant ($P<0.05$) in 2014 cropping season (Table 1). *Nwopoko* ware yam cultivar had the highest incidence of nematode infestation within the cropping season compared to the other cultivars. Fresh tuber yield exhibited highly significant ≤ and positive association with weight of yam tubers/plot and bulking rate in both years (Table 2). However, there was highly significant correlation between fresh tuber yield and number of ware-yam tubers/plot and with number of seed yam tubers/plot in 2014 and 2015, cropping seasons, respectively. Also, in 2014 cropping season, weight of yam tubers/plot and bulking rate exhibited highly significant association with number of ware-yam tubers/plant contrary to 2015 while in both cropping seasons, bulking rate had very strong and positive association with weight of yam tubers/plot. The results of the correlation evaluation of the variants were similar to previous reports by Quin (1998), NRCRI annual report (1998), Balogun *et al*. (2006) in their studies on mini-tuberization of white-yam as well as Muamba *et al*. (2013) in their studies on the use of vine cuttings in the production of yam tubers. The relationship between nematode incidence and fresh tuber yield was poly-linear and positive (Figs. 1a and b) indicating decline in fresh tuber yield·ha^{-1} as incidence of nematode infestation increased before a slight plateau and then a slight upward increment in yield with increased incidence of nematode indicating minor degree of resistance by the yam cultivars to the pest. Furthermore, this indicates that increase in nematode incidence does not automatically relate to linear decline in tuber yield amongst the ware yam cultivars.

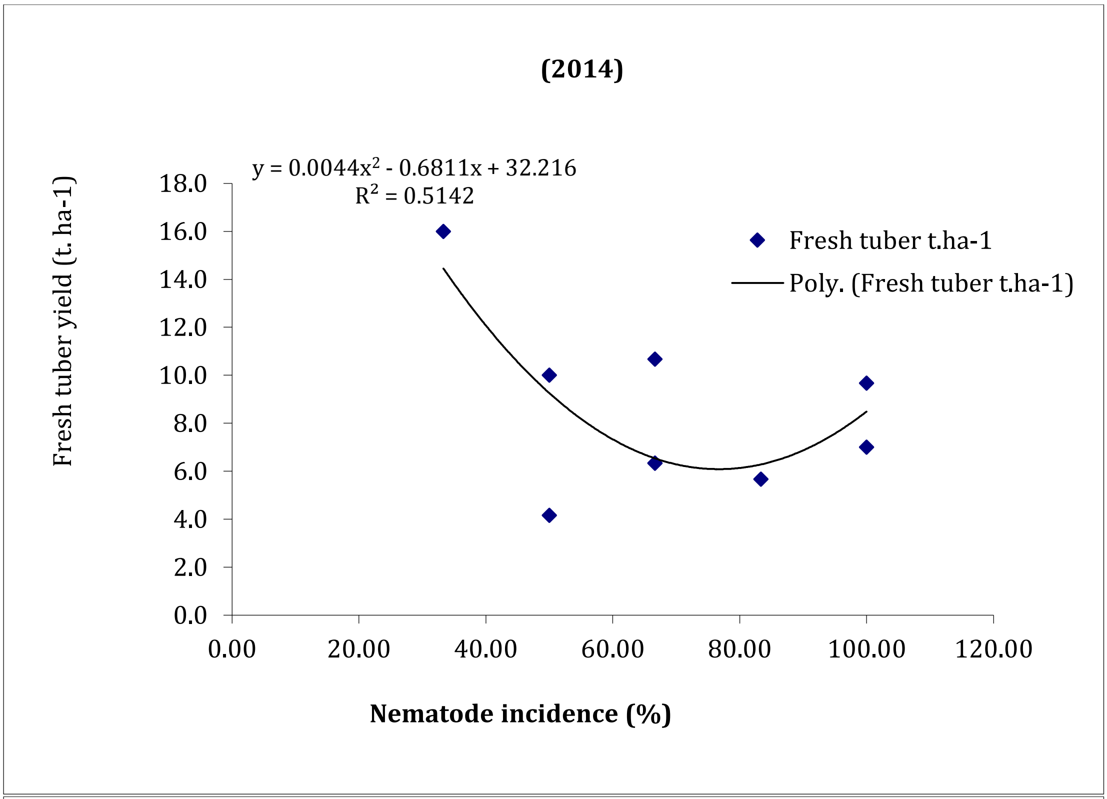
Table 1: Yield and yield components of three ware-yam cultivars in 2014 and 2015 cropping seasons

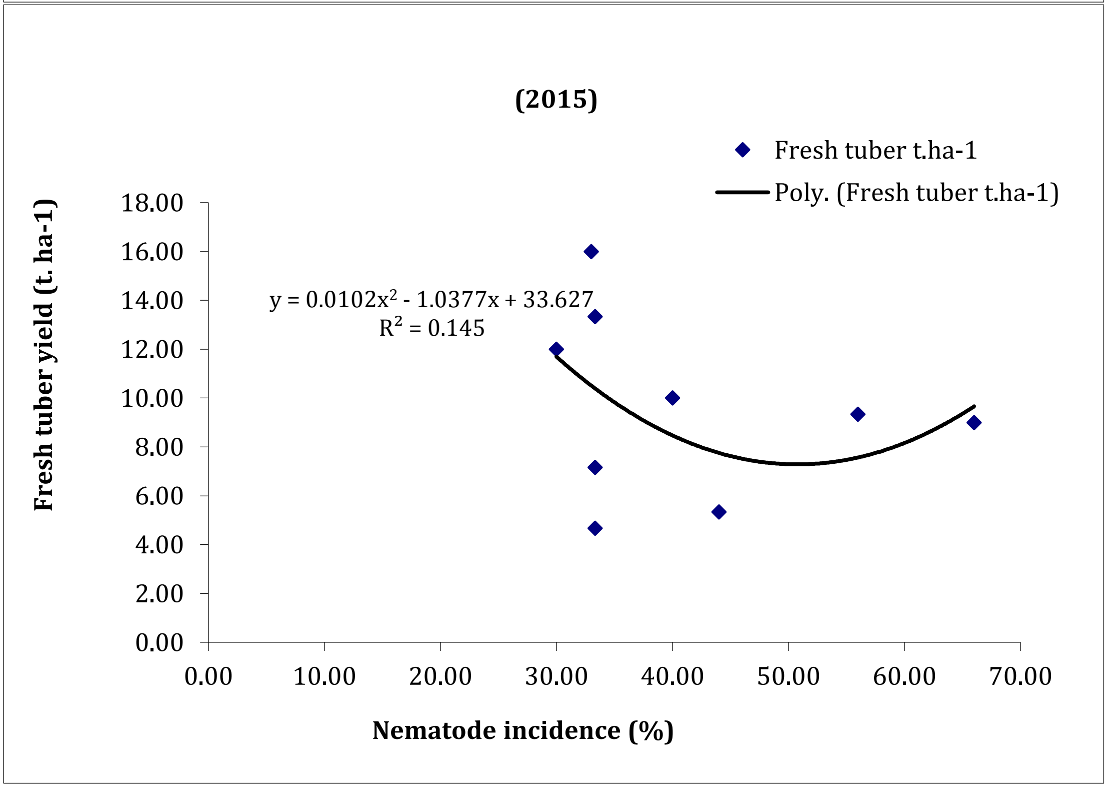
Treatment	No. of seed yams plot^{-1}	No. ware-yams plot^{-1}	Fresh tuber yield plot^{-1} (kg)	Bulking rate (kg^{-1} day^{-1} ha^{-1})	Nematode incidence plot^{-1} (%)	Fresh tuber yield (t ha^{-1})
2014						
Nwopoko	6.67	1.33	3.23	14.8	66.7	5.39
Hebamkwase	8.33	2.33	4.60	21.0	68.9	7.67
Alumaco	9.33	3.00	7.33	33.5	50.0	12.22
$LSD_{(0.05)}$	ns	1.49	2.694	12.30	35.10	4.491
S.E.D	1.70	0.609	1.101	5.03	14.34	1.835
Meeam square	5.444	2.1111	13.074	272.61	1142.0	36.318
F Pr.	0.350^{ns}	0.086*	0.026*	0.026*	0.090*	0.026*
2015						
Nwopoko	3.33	1.33	3.43	15.7	22.2	3.43
Hebamkwase	4.67	2.33	6.07	27.7	0.00	6.07
Alumaco	7.33	3.67	7.87	35.9	16.7	7.87
$LSD_{(0.05)}$	1.153	1.153	2.535	11.57	ns	2.535
S.E.D	0.471	0.471	1.036	4.73	12.00	1.036
Meeam square	12.4444	4.1111	14.914	310.92	401.20	14.914
F Pr.	<0.001***	0.007**	0.015*	0.015**	0.236^{ns}	0.015**

Table 2: Linear correlation matrix between six variants of ware-yam grown in 2014 (below diagonal) and 2015 (above diagonal) cropping seasons

Plant characters	Fresh tuber yield (Mt ha^{-1})	No. seed yam tubers /plot	No. ware-yam tubers /plot	Weight of yam tubers/plot (g)	Bulking rate (Kg month^{-1} ha^{-1})	Nem-atode incidence (%)
Fresh tuber yield (Mt ha^{-1})	1.00	0.82**	0.61	1.00**	1.00**	-0.22
No. seed yam tubers/plot	0.55±	1.00	0.82**	0.82**	0.82**	-0.21
No. ware-yam tubers/plot	0.80**	0.23	1.00	0.61	0.61	0.04
Weight of yam tubers/plot (g)	1.00**	0.55	0.80**	1.00	1.00**	-0.22
Bulking rate (Kg month^{-1} ha^{-1})	1.00**	0.55	0.80**	1.00**	1.00	-0.22
Nematode incidence (%)	-0.40	-0.22	-0.40	-0.40	-0.40	1.00

**, Correlation is significant at the 0.01 level (2-tailed); ±, Correlation is non-significant





Figs. 1a and b: Relationship between nematode incidence and fresh tuber yield (Mt·ha^{-1}) in 2014 and 2015 cropping seasons with quadratic regression lines.

Conclusion

In both years, tuber yields of the tested cultivars were significant. *Alumaco* had the highest tuber yield relative to *Nwopoko* and *Hebamkwase* other cultivars studied and exhibited the least percentage of nematode incidence in both years. The mean sequence of tuber yield of the ware-yam cultivars in the order: *Alumaco* > *Nwopoko* > *Hebamkwase* in 2014 and 2015 cropping seasons. Fresh tuber yield (t ha^{-1}) indicated highly significant ($P \leq 0.01$) and positive correlation with all the yield attributes, especially weight of tubers/plot and bulking rate in both years with correlation coefficients (r) ranging from 0.55 to 1.00 (2014) and 0.61 to 1.00 (2015). Also, the regression analysis showed a poly-linear and positive relationship between nematode incidence and fresh tuber yield of ware-yam in both years. *Alumaco* ware-yam cultivar was the highest yielder, hence adjudged to be better endowed genetically to be recommended to farmers within the agro-ecological zone of the study area.

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Effect of Nitrogen and Poultry Manure on the Performance of Cucumber (*Cucumis sativus* L) in sudan savanna

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Abstract
This study was carried out in the dry season of 2017 at the Teaching and Research Farm of Federal University of Dutsin-Ma, Katsina State, Nigeria, to determine the influence of nitrogen and poultry manure application on cucumber (Cucumis sativus L) performance. The treatments consisted of three levels of nitrogen (0, 40 and 80 kg N ha^{-1}) and four levels of poultry manure (0, 5, 10 and 15 t ha^{-1}) arranged in a randomized complete block design and replicated three times. Application of 40 and 80 kg N ha^{-1} was not significant on growth and yield performance of cucumber. However, application of 80 kg N ha^{-1} gave the highest response on fruit yield of cucumber. Fertilization with poultry manure significantly increased number of leaves per plant, number of branches per plant, fruit length per plant, fruit diameter per plant and fruit yield of cucumber. Application of 10 t ha^{-1} of poultry manure seems to be appropriate for growth and yield of cucumber in this area of study. Application of 5, 10 and 15 t ha^{-1} of poultry manure produced 548, 816.1 and 985.3% increases in cucumber fruit yield when compared with no poultry manure application, respectively.

Introduction
Soil infertility has been an unabated challenge in the growth and yield of any crop in Savanna zone of Nigeria. It has been reported that that Nigerian savanna soils are low in organic carbon, total nitrogen, available phosphorus, effective CEC and exchangeable cations as well as clay and silt contents (Singh, 1987). They are generally poorly buffered and structured and hence they have major chemical, physical and biological limitations (Acquaye, 1974; Jones and Wild, 1975; Kowal and Kassam, 1978). The afore mentioned constraints make it necessary to employ an addition of inputs like inorganic fertilizers such as nitrogen and organic fertilizers such poultry manure worthwhile especially when growing cucumber. It should be of note that crop nitrogen requirement is a physiological component which has a direct relationship to the genetic potential of a crop and its plant growth condition (Zotarelli *et al*., 2009). The use of organic manures like poultry manure is one of the most environmental friendly agricultural technologies which improve the soil physical properties, fertility level and micro flora (Seo *et al.*, 2000). Poultry manure has been reported to contain high percentage of nitrogen and phosphorus for plant healthy growth (Ewulo, 2005). A proper plan of organic and inorganic fertilizer program will definitely improve soil fertility status and consequently enhance crop growth and development for better crop yield and hence, a better income for farmers. It has been observed that maximum net returns in crop production can adequately be sustained with adequate fertilizer program that will supply the amounts of plant nutrients needed (Leonard, 1986). However, the use of chemical fertilizers like nitrogen is very low in Nigeria because of high cost of these inputs while organic manure, which should serve as alternative, is also required in a very large quantity which farmers always find difficult to meet the required quantities for their farms. Although, importance of organic manure in general well-being of soils cannot be over emphasis. Organic manure enables a soil to hold more water, improve the drainage and organic acids that help to dissolve soil nutrients and then make them available for the crops (Deskissa *et al*., 2008). Ologunde (1987) reported that nitrogen is the most limiting factor for production of crops on soils around the world. Hence, there is a need for constant addition of this nutrient especially in

semi-arid environment where this experiment was carried out. Soils of semi-arid environment of Nigeria is known for low organic carbon content which makes addition of poultry manure a good measure of correcting this deficiency. Therefore, this study was conducted to evaluate the influence of application of nitrogen and poultry manure on cucumber performance.

Materials and Methods

The trial was conducted in the dry season of 2017 at the Research Farm of Federal University Dutsin-Ma, at Badole (Longitude $07^0$29'29" E and Latitude $12^0$27'18" N) with altitude of 605 m in the Sudan savanna ecological zone of Nigeria. The treatments consisted of three levels of nitrogen (0, 40 and 80 kg N ha^{-1}) and four levels of poultry manure (0, 5, 10 and 15 t ha^{-1}). The treatments were arranged in a randomized complete block design with various factorial combinations and replicated three times. The experimental plot consisted of four rows of 1.5m apart and 2m long (gross plot) and net plot was 1m x 2m ($2m^2$).The experimental field was harrowed and consequently watered by flooding method. The field was further harrowed to give fine tilths and prepared into raised beds (plots) of 1.5m x 2m in basin form for irrigation purpose. Poultry manure was added to various plots by thoroughly mixing the manure with soil according to the treatments at two weeks before planting. Seeds of exotic variety named PIONSETTE 44 were planted with two seeds per hole at a spacing of 50cm x 50cm on the beds at two weeks after poultry manure incorporation. The cucumber seedlings were thinned to one seedling per stand at two weeks after sowing. Nitrogen fertilizer as urea (46%N) was applied to the cucumber at 2 weeks after sowing (WAS) according to treatments. The field was irrigated twice a week using basin method. Weeds were controlled using hoe at 3 and 6WAS. Samplings on number of leaves and branches per plant were done at 4 ad 6 weeks after sowing (WAS) while fruit length, fruit diameter and fruit yield were obtained at harvest. Data collected from the observations were subjected to statistical analysis of variance (ANOVA) as described by Gomez and Gomez (1984) using SAS package version 9.0 of statistical analysis (SAS institute, 2002). The differences among treatment means were separated using Duncan's Multiple Range Test (Duncan, 1955). Effects were considered statistically significant at 5% level of probability.

Results and Discussion

Application of nitrogen was not significant on number of leaves per plant and number of branches per plant (Table 1). Application of poultry manure had significant effect on number of leaves of cucumber per plant at both 4 and 6WAS (Table 1). Application of 5 and 10 t ha^{-1} of poultry manure at 4WAS, and 5 and 15 t ha^{-1} at 6WAS significantly increased number of leaves per plant which was statistically similar with application of 15 t ha^{-1} at 4WAS and 10 t ha^{-1} at 10WAS (Table 1). Application of 5 t ha^{-1} of poultry manure significantly increased number of branches per plant at 4 and 6WAS which was statistically similar with application of 10 and 15 t ha^{-1} of poultry manure (Table 1). Plots that received poultry manure produced significantly higher number of branches per cucumber plant than plots that received no poultry manure. Plots that received nitrogen fertilization did not show significant effect on fruit length per plant, fruit diameter per plant and fruit yield (Table 2). Application of 5 t ha^{-1} of poultry manure significantly increased fruit length per plant and fruit diameter per plant which was statistically similar with application of 10 and 15 t ha^{-1} of poultry manure (Table 2). Plots that received poultry manure produced significantly longer fruit and fruit diameter than plots that received no poultry manure. Application of 5 and 10 t ha^{-1} of poultry manure significantly increased fruit yield of cucumber (Table 2) but there was no significant difference between application of 10 and 15 t ha^{-1} of poultry manure on cucumber fruit yield. Application of 5, 10 and 15 t ha^{-1} of poultry manure produced 548, 816.1 and 985.3% increases in cucumber fruit yield over zero poultry manure control, respectively (Table 2). Interaction between nitrogen and poultry manure was not significant on the parameters measured in this experiment.

Table 1: Influence of nitrogen and poultry manure on number of leaves per plant and number of branches per plant of cucumber at 4 and 6WAS

	No of leaves per plant		No of branches per plant	
Treatment	**4WAS**	**6WAS**	**4WAS**	**6WAS**
Nitrogen(N) Kg ha^{-1}				
0	10.64	40.08	3.60	8.71
40	9.81	45.53	3.78	10.33
80	9.53	45.50	3.79	9.67
SE±	0.43	2.8	0.34	0.66
Poultry manure(P) T ha^{-1}				
0	6.30c	21.41c	1.85b	6.00b
5	10.08b	44.33b	4.02a	9.83a
10	12.30a	52.48ab	4.59a	11.28a
15	11.30ab	56.59a	4.43a	11.17a
SE±	0.49	3.24	0.39	0.76
NxP	NS	NS	NS	NS

NS: Not significant
Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT

Similarity observed among nitrogen levels on all the parameters measured could be that the soil total nitrogen of the experimental field was adequate for the growth of cucumber. Hence, fertilizing the soil with nitrogen produced similar effect on the cucumber irrespective of the various rates of the added nitrogen. It could also be that the rates of the nitrogen were not adequate to exert significant influence on the measured parameters. Similarly, Van Eerd and O'Reilly (2009) observed that application of nitrogen did not significantly increase cucumber fruit which was attributed to sufficient soil mineral N over the growing season.
Significant increases observed on number of leaves per plant and number of branches per plant could be attributed to the ability of poultry manure to increase the organic matter (OM) content of soil and in turn releases the plant nutrients in available form for the use of the plants (Okoli and Nweke, 2015). Similarly, Nweke et al. (2014) and Okoli and Nweke (2015) reported an increase in cucumber growth after poultry manure fertilization. The mark increases observed on fruit length and fruit diameter following poultry manure application could be attributed to the positive effect of poultry manure on number of leaves per plant and number of branches per plant which culminated in marked increase observed on these yield components. Hamma *et al*., (2012) and Enujeke(2013) observed similarly that poultry manure significantly increased yield parameters of cucumber. Significant increase observed on fruit yield of cucumber after application of poultry manure could be attributed to the increases observed on growth and yield parameters which translated to the better fruit yield. The significant fruit yield after poultry manure fertilization could also be as a result of the improvement in the soil organic matter, release of embedded soil nutrients, increase in soil microbial population and improvement in soil quality. Okoli and Nweke (2015) made similar observation of significant increase in cucumber fruit yield which was attributed to the nutrient content of poultry manure which translated into high vegetative growth resulting in high photosynthetic activities which culminated into high yield observed in plants that received poultry manure. The not significant interaction between nitrogen and poultry manure on the measured parameters could be that both nitrogen and poultry manure did not exert significant effect on each other.

Table 2: Influence of nitrogen and poultry manure on fruit length per plant, fruit diameter perplant and fruit yield of cucumber

Treatment	Fruit length (cm)	Fruit diameter(cm)	fruit yield (Kg ha^{-1})
Nitrogen(N) Kg ha^{-1}			
0	20.63	5.55	36783
40	20.77	5.61	38608
80	21.43	5.78	41342
SE±	0.51	0.1	1128.8
Poultry manure(P) T ha^{-1}			
0	18.98b	4.94b	5661c
5	20.99a	5.77a	36683b
10	21.39a	5.89a	51861a
15	22.40a	5.98a	61439a
SE±	0.59	0.12	1303.4
NxP	NS	NS	NS

NS: Not significant
Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT

Conclusion

Based on the results obtained from this study, it can be concluded that that application of 40 and 80 kg Nha^{-1} did not significantly influence growth and yield of cucumber. Poultry manure fertilization at the rates of 5, 10 and 15 t ha^{-1} exerted significant influence on growth and yield performance of cucumber. However, application of 10 t ha^{-1} of poultry manure seems to be appropriate for the production of cucumber in Sudan savanna ecological zone of Nigeria. Poultry manure must have made available its embedded nutrients through mineralization, created conducive environment for soil microbial activity and exerted big influences on soil physical, chemical and biological properties for enhanced cucumber performance.

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Bulking Rate as an Index of Maturity in Yam Varieties (*Dioscorea rotundata)*

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Abstract
This study was conducted to evaluate bulking rate as an index of maturity in yam varieties (Dioscorea rotundata). The experiment was conducted at the National Root Crop Research Institute (NRCRI) Umudike, Southern Nigeria. Planting materials include: - 001, 002, 003, 006, and 008, all Dioscorea rotundata white cultivar. These materials will be Sett sizes 50 – 150 g. The experiment was laid out in a randomized complete block designed (RCBD) with five replications. The experimental subjects, (the yam varieties) become the treatments. The planting space will be: 1m x 1m while The sett sizes will be: 50 g – 150 g. Pot size depth will be 10 m x 15 m width. Plot size was 5 m x10 m (50 m). Results showed that no statistical significant (p>0.05) variations were obtained in bulking rate of the five varieties with respect to variety to variety interaction. However, bulking rate increased from 8WAP through 24 WAP across all yam varieties. The variety interaction showed no statistically significant (p>0.05) difference, however, the average tuber weight across the sampling dates was highest in Adaka and lowest in Hembakwase, specifically at 8weeks sampling date. Fresh tuber weight was highest in Amula in 2017 and least in Hembakwase in 2016. At 16 weeks sampling date Adaka recorded the highest fresh tuber weight, while Ame had the least tuber weight in 2016. At 24 week sampling date fresh tuber was highest in Adaka and lowest in Ame both in 2017 cropping season. The bulking rate of the five varieties has reveal time and physical characters which may aid in easy identification of maturity in yam. Yam varieties performed differently in in the Yam yield although the growth parameters did not vary a lot. Adaka from this study showed the best bulking rate and yield values. Hence, it is not out of place to recommend that its adaptation properties may aid good yam production.
Keywords: Yams, Dioscorea, Maturity, Bulking rate and Yield

Introduction
Yams (*Dioscorea* species of family Dioscoreaceae) are important for food, medicine, income and socio-cultural events. They are a leading source of calories for over 300 million people in the tropics and subtropics (Degras, 1993). The crop is grown in Africa, Asia, parts of South America, as well as the Caribbean and the South Pacific islands. In West Africa, about 48 million tons of yams are produced annually on 4 million hectares of arable land. Out of the more than 600 species, 10 are generally cultivated as food: *D. alata*, *D. rotundata, D. cayenensis, D. bulbifera, D. esculenta, D. opposita-japonica, D. nummularia, D. pentaphylla, D. transversa* and *D. Trifida* (Lebot, 2009). *D. rotundata* and *D. cayenensis*, (together also referred to as *D. cayenensis–rotundata* complex) are indigenous to Africa, and represent most of global yam production. They have the highest market value owing to the superior suitability of their tubers to the preferred food uses for the crop in West Africa. High yield potential and early maturity are important characteristics for production. Cultivars that are high yielding and early maturing will enhance production, and may also permit double cropping within a year. This will enable food yam to be available in the market for most of the year. However, crop yield is determined by several related factors, and tuber maturity in yam is difficult to measure directly. Bulking rate refers to the rate of tuber initiation and development; it is also one of the major determinants in the measurement of earliness in maturity, high tuber yields, high forage yield and productivity per unit time in Sweet potato ((Degras, 1993).). The yams (*Dioscorea* spp.) have several botanical peculiarities of their

own. One of these peculiarities is that the tubers which they produce originate neither from the stem; instead they arise from the hypocotyl region of the plant (Lebot, 2009). It is not surprising therefore that the tuber itself exhibits several unique morphological and physiological characteristics. Many of these characteristics profoundly influence the productivity of the crop on the field, and determine how best the crop can be managed for optimum yields.

Materials and Methods

Study Area

The experiment was conducted at the National Root Crop Research Institute (NRCRI) Umudike, Southern Nigeria to study the use of bulking rate as an index of maturity in yam varieties. Umudike is located at Latitude 5° 29' N and Longitude 7°33' E in the rainforest agro-ecological zone of South Eastern Nigeria. It has an annual rainfall that ranges between 1800 mm - 2200 mm. This lies at about 122m above sea level.

Planting Materials

Planting materials include: - 001, 002, 003, 006, and 008, all *Dioscorea rotundata* white cultivar. These materials will be Sett sizes 50 – 150 g.

Field Preparation and Soil Sampling

The site was slashed, harrowed, ploughed and ridged at the onset of the raining season in April. A composite soil samples were collected with a soil auger to the depth of 20cm before ploughing the land. The samples were air dried, passed through 2mm sieve and analyzed for their physical and chemical properties. The experimental area was marked out into replicates and each replicates were divided into five experimental units (plots). Each plot was measured 5m x 10m ($50m^2$).

Experimental Design, Treatments and Treatment Allocation

The experiment was laid out in a randomized complete block designed (RCBD) with five replications. The experimental subjects, (the yam varieties) become the treatments. The planting space will be: 1m x 1m while The sett sizes will be: 50 g – 150 g. Pot size depth will be 10 m x 15 m width. Plot size was 5 m x10 m (50 m)

Data Collection

Data will be collected on the following parameters:

1. Tuber initiation or bulking at 2, 4, 6, and 8 months.
2. Selection index at 8 month
3. Yield component at harvest include :-
4. Tuber yield: it was obtained by converting the mean tuber weight of each plot in tons per hectare.

Data Analysis

The data collected will be subjected to ANOVA and means will be compared using LSD.

Results and Discussion

Bulking Rate of yam varieties in 2016/ 2017 cropping seasons

Bulking rate shortens the period of growth from planting to harvesting. The bulking rate of five yam varieties over a two year cropping season (2016/2017) is presented in table 1. Results showed that no statistical significant (p>0.05) variations were obtained in bulking rate of the five varieties with respect to variety to variety interaction. However, bulking rate increased from 8WAP through 24 WAP across all yam varieties.

Table 1: Bulking rate of Yam varieties in 2016 and 2017 cropping seasons

Treatment	2016 8WAP Tuber yield (kg)	16WAP Tuber yield (kg)	24WAP Tuber yield (kg)	2017 8WAP Tuber yield (kg)	16WAP Tuber yield k(g)	24WAP Tuber yield (kg)
Adaka	1.97	3.22	3.37	2.78	4.05	12.7
Ame	0.9	2.0	3.16	1.01	2.29	7.8
Amula	1.12	3.42	4.91	1.81	3.19	9.7
Hemba	1.22	2.63	3.78	2.19	3.51	8.3
Yandu	1.45	4.08	3.73	1.5	2.3	11.3
$LSD_{0.05}$	1.615^{NS}	2.057^{NS}	1.6^{NS}	1.732^{NS}	2.217^{NS}	8.38^{NS}

Yield of five varieties at different yield component stages in 2016 and 2017

Table 2 is a presentation of the tuber weight of five varieties and showed a general sharp increase in tuber weight from 4WAP through 24WAP. The variety interaction showed no statistically significant (p>0.05) difference, however, the average tuber weight across the sampling dates was highest in Adaka and lowest in Hembakwase, specifically at 8weeks sampling date. Fresh tuber weight was highest in Amula in 2017 and least in Hembakwase in 2016. At 16 weeks sampling date Adaka recorded the highest fresh tuber weight, while Ame had the least tuber weight in 2016. At 24 week sampling date fresh tuber was highest in Adaka and lowest in Ame both in 2017 cropping season.

Table 2: Yam tuber yield of five varieties at different yield component stages in 2016 and 2017 cropping seasons

Treatments	2016	2017	2016	2017	2016	2017
	8WAP (kg)		16WAP (kg)		24WAP (kg)	
Adaka	0.029	0.0348	0.155	0.159	0.019	1.09
Ame	0.0089	0.0127	0.138	0.160	0.145	0.68
Amula	0.0088	0.0219	0.288	0.172	0.186	0.81
Hemba	0.0086	0.0274	0.176	0.165	0.144	0.60
Yandu	0.0151	0.0187	0.328	0.100	0.043	1.13
LSD 0.05	0.0330^{NS}	0.02178^{NS}	0.1583^{NS}	0.0843^{NS}	0.2645^{NS}	1.176^{NS}

The general observation of early tuber formation across the varieties may be due to similarity in fertilizer application, as this may have aided tuber formation. Similar claims on the effect of fertilizer on tuber formation were made by Law-Ogbomo and Osaigbovo (2014). They concluded that the yam plant showed the usefulness of fertilizer application in improving its productivity as the tuber yield was reduced where fertilizer was not applied at all. This may be related to insufficient nutrient uptake as the plants have to rely on the on the native fertility of the soil which has been shown to be deficient in primary nutrients (N, P and K). This soil condition may be the reason why the leaf area was high and in turn aided the early initiation of tubers. Law-Ogbomo and Remison (2008) reported that the significant correlation between fresh tuber yield and the leave area ($r = 0.65$; $p < 0.05$). the increase in the bulking rate over time and the observe higher bulking rate of in 2017 over that of 2016 across the periods of observation may be as a result of difference in the grow factors such as leave area index, vine length, leave number, which may have ensured better utilization of the solar radiation. Adaka, Amula, and Yandu in 2017 recorded tuber numbers that increased with growth period respectively. The reduction in number of tuber yield over time as observed in this study was also reported by Marie-Vianney *et al*. (2008) were at 40 WAP the yam varieties started showing a reduction in the number of tubers counted, this may be a pointer to the knowledge that yam may not increase its tuber number if the maximum number has been reached irrespective of the time and go further to suggest that at its peak of tuber number maturity and other subsequent physiology of the tuber may set in.

Conclusion

The Bulking rate of the five varieties has reveal time and physical characters which may aid in easy identification of maturity in yam. Yam Varieties performed differently in in the Yam yield although the growth parameters did not vary a lot. Adaka from this study showed the best bulking rate and yield values. Hence, it is not out of place to recommend that its adaptation properties may aid good yam production. Yam agronomy requires further research on Better ways to monitor responses and the effectiveness of Yam varieties to agronomic practices and maturity.

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The effect of cow dung and poultry manure on the growth and yield of amaranthus hybridus (green)

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Abstract
A field experiment was conducted at the Research farm of Imo state Polytechnic Umuagwo – Ohaji, owerri, Nigeria in 2016 cropping season. The objective of the study was to evaluate the effect of cow dung and poultry manure on the growth and yield of A. hybridus. The experiment was laid out in a Randomized complete block design (RCBD) with four replicates the treatment were 10t/ha of cow dung manure 10t/ha of poultry manure, a mixture of 5t/ha each of cow dung and poultry manure and the control, result shoed that amending soil with poultry manure greatly improved the soil fertility and subsequent growth and yield of a. hybridus. This as due to the high level of nitrogen present in it. The mixture of cow dung and poultry also performed well. The cow dung manure gave a good growth and yield of A. hybridus but not as the mixture the control gave the least performance as it lacked the nutrients required for proper growth and yield of A. hybridus. Thjis work has shown that a good soil amendment especially with poultry manure is needed for a good growth and yield of A. hybridus.

Introduction
Plants depend on some essential elements for proper growth and development. However natural disasters like erosion, leaching and run-offs have really been a problem to farm crops especially vegetables as they cause the depletion of soil nutrients (Ewulo, 2005). Animal manure is known to be effective in the maintenance of adequate supply of organic material in the soil with improvement in soil physical and chemical condition and enhanced crop performance (Ikpe and Poel, 2002). Organic manure consists of natural and biodegradables components and elements which can be easily worked upon by microorganisms and reach plants safely. It reduces soil acidity and does not cause leaching. Organic manure is a source of major nutrients – nitrogen, phosphorus and others as well as some micronutrients. It increases the ability of the soil to hold water and nutrients and keeps improving soil even after the crops are removed. Amaranthus hybridus is a leafy green vegetable which is very rich in vitamins it belongs to the family Amaranthaceae and is a native of tropical America (Budin et al, 1996). Since the cost of producing this vegetable using inorganic fertilizer is expensive, the fertilizer itself is not ecofriendly among other factors this work is aimed at investigating the effect of cow dung and poultry manure on the growth and yield of Amaranthus hybridus

Materials and Methods
The experiment was conducted at the research farm of Imo state Polytechnic, Umuagwo Ohaji, Imo state. The experimental materials ere procured from imo state Agricultural Development office owerri. 10t/ha of cured poultry manure, 10t/ha of cured cow dung manure and 10t/ha of a mixture of both were applied to the already prepared beds two weeks before planting. Seedlings raised in the nursery were transplanted into the field measuring 49m2. The parameters used were plant height, number of leaves, number of branches, stem girth and mean leaf yield were measured at 2, 4, 6 and 8 WAP using plants which were randomly selected. Leaf weight was obtained by weighing the leaves on a salter weighing balance. The data obtained were subjected

to analysis of variance for a randomized complete block design (RCBD) and the means ere separated using least significant difference (LSD) at 5% level of probability

Results and Discussion

Table 1 shows a significant difference in the mean plant height of A. hybridus at 2 WAP between the control and the other treatments and the same trend continued till 8 WAP. This agrees with the report of Ayoola and Adediran, 2006 that organic manure can be used to improve the fertility of soil. Tables 2, 3 and 4 shows that there is no significant difference in the mean number of branches, mean number of leaves and mean stem girth of A. hybridus at 2, 4, 6 and 8 WAP although the T2 and T3 gave the best results. The good performance given by poultry manure agrees with the report of Smith and Ayenigbara, 2001, which showed that poultry manure contains a higher value of Nitrogen when compared to cow dung manure. Table 5 shows a significant difference in the mean leaf yield of A. hybridus under different manure application between t2 (poultry) and t1 (cow dung), a significant difference also existed beteen t2 and t3 indicating that combining poultry and cowdung manure can improve the soil better than using only cow dung manure. A significant difference existed also beteen the control and each of the treatments showing that amending soil using organic manure has a positive influence on the soil (Ano and Agwu, 2005; Joann Nwajiuba and chimezie, 2000). The control (To) had the leastr performance owing to the fact that it lacked the required nutrients for proper growth and yield of A. hybridus. This agrees with the work of Hague and Lupwayi, 2003 who reported that poor nutrient availability to the soil produces low yield. Thus poultry manure (t2) performed better than all the other treatments and this agrees ith the work of marere and Nonga, 2001 who reported that poultry manure has a high level of soil organic properties such as nitrogen and potassium which makes it better than cowdung manure.

Table 1: Mean plant height of *Amaranthus hybridus* at 2, 4, 6 and 8 WAT under different manure application

Manure Treatment		Plant Height (Cm)		
	2	4	6	8 (W.A.T)
T0	3.50^{b}	5.55^{b}	7.73^{b}	9.93^{b}
T1	4.37^{a}	6.40^{a}	8.60^{a}	10.8^{a}
T2	4.63^{a}	6.57^{a}	8.77^{a}	10.97^{a}
T3	4.53^{a}	6.50^{a}	8.70^{a}	10.90^{a}
LSD 0.05	0.62	0.41	0.41	0.41

Means in the same column having the same letters are not significantly different at $p \leq 0.05$ according to LSD test

Table 2: Mean numbers of branches of A. hybridus per plant at 2, 4, 6 and 8 WAT under different manure application

Manure Treatment		Numbers Of Branches Per Plant		
	2	4	6	8 (W.A.T)
T0	3.33^{a}	5.33^{a}	7.33^{a}	9.33^{a}
T1	5.00^{a}	7.00^{a}	9.00^{a}	11.00^{a}
T2	5.67^{a}	7.67^{a}	9.67^{a}	11.67^{a}
T3	5.33^{a}	7.33^{a}	9.33^{a}	11.33^{a}
LSD 0.05	2.92	2.92	2.92	2.92

Means in the same column having the same letters are not significantly different at $p \leq 0.05$ according to LSD test

Table 3: Mean number of leaves per plant of A. hybridus at 2, 4, 6 and 8 WAT under different manure application

Manure Treatment	Number Of Leaves Per Plant)			
	2	4	6	8 (W.A.T)
T0	7.33[a]	9.33[a]	11.33[a]	13.33[a]
T1	4.67[a]	6.67[a]	8.67[a]	10.67[a]
T2	6.67[a]	8.67[a]	10.67[a]	12.67[a]
T3	5.33[a]	7.33[a]	9.33[a]	11.33[a]
LSD 0.05	3.06	3.06	3.06	3.06

Means in the same column having the same letters are not significantly different at $p \leq 0.05$ according to LSD test

Table 4: Mean stem girth (cm) of A. hybridus at 2, 4, 6 and 8 WAT under different manure application

Manure Treatment	Stem Girth			
	2	4	6	8(W.A.T)
T0	1.60[a]	3.80[a]	6.00[a]	7.90[a]
T1	1.60[a]	3.80[a]	6.00[a]	8.00[a]
T2	1.70[a]	3.90[a]	6.03[a]	8.23[a]
T3	1.70[a]	3.90[a]	6.10[a]	8.30[a]
LSD 0.05	0.29 0.29 0.28 0.28			

Means in the same column having the same letters are not significantly different at $p \leq 0.05$ according to LSD test

Table 5: Mean leaf yield (Kg/ha) of *A. hybridus* under different manure application

Manure Treatment	Mean Leaf Yield(Kg/Ha)
T0	133.62[a]
T1	233.59[c]
T2	304.27[a]
T3	242.74[b]
LSD 0.05	0.61 0.41 0.41 0.41

Means in the same column having the same letters are not significantly different at $p \leq 0.05$ according to LSD test

Conclusion

In conclusion, amending soil with organic manure improved the fertility of soil, for the growth and yield of A. hybridus though poultry was more effective than cow dung manure due to high level of organic Nitrogen and carbon present in it.

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Agronomic Strategies towards Sustainable Cowpea Production in Nigeria: Effects of Variety and Weeding Regime

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Abstract
The field experiment was conducted at the Eastern Research Farm of Michael Okpara University of Agriculture Umudike to investigate the suitable weeding regime to enhance yield of 4 varieties of vegetable cowpea (Vignaunguiculata (L). Walp). The experiment was set up as a split-plot in randomized complete Block Design (RCBD) with the vegetable cowpea varieties (ITO3K-324-9, IT98K-692, 1T99K-377-1 and IT04K-399-1) occupying the main plot and the weeding regime (weed X1, weed X2, weed free and NO weeding) occupying the subplot. Variety 1T04K-339-1 significantly improved plant height, number of branches, number of leaves and leaf area of vegetable cowpea at 4 WAP, while at 8 WAP, variety 1T99K-377-1 proved superior over other varieties in plant height, leaf area and number of seeds/pod. Yield parameters were maximized when variety 1T03K-324-9 was grown, despite its poor growth characteristics. The study identifies single weeding at 4 WAP as being most conducive for optimum yield of vegetable cowpea varieties under Umudike conditions.

Introduction
Cowpea (*Vignaunguiculata (L).Walp*) is an annual legume with lots of common names, such as Crowder pea, black-eyed pea and southern pea, lubia, niebe, coupe or frijoles (Adediran*et al.,* 2005). The largest production of cowpea is in African with Nigeria and Niger predominating, but Brazil, India, Australian and U.S. all have significant production. There are two types of cowpea, the seed type and vegetable type (for leafy greens, green pods fresh shelled green peas and shelled dried peas) (Adediran*et al.,* 2005; Ekeleme and Nwofia, 2005; Umaharam*et al.,* 1997) in the humid forest fringes,. The most widely grown varieties are the vegetable types whose immature succulent pods are eaten by humans. (Ekeleme and Nwofia, 2005). It is usually grown as companion crop in yam, cassava and their mixtures. Cowpea is a food legume that plays a critical role in the lives of millions of people in Africa and other parts of the developing world. Both the grain and the haulm, which serves to improve the nutrient level of the crop, are valuable dietary proteins for the African human population and their livestock (Fatokun, 2002). Cowpea is a deep rooted crop and does well in sandy soils and more tolerant to drought than soybean. The crop is a major component of the tropical cropping system because of its ability to improve marginal lands through nitrogen fixation and as a cover crop (Sanginga *et al.,* 2003; Abayomi, 2009).The crop is of major importance to the livelihoods of millions of people in the tropics. For resource-poor small-holder farmers, the crop serves as food, animal feed, cash and manure. Weed infestation is a major constraint to crop production. Cowpea is generally susceptible to weed infestation at all periods of growth; the most damaging effects occurring during the early stage after planting (Onochie, 1975). Its competition with weeds depends, to some extent, on how long after planting the crop stays weed-free before the canopy covers the ground. Weeds are removed by hand pulling and traditional hoe. This method is labor intensive and often not appropriate during flowering stage (Ekeleme*et al.,* 2003). A experiment was carried out to determine the growth, yield and yield components of four vegetable cowpea cultivars when subject to different weeding regimes in Umudike, Southeastern Nigeria.

Materials and Methods
Four varieties of vegetable cowpea (IT98K-692, IT03K-324-9, IT99K-1 and IT04K-339-1) obtained from the International Institute of Tropical Agriculture (IITA) Ibadan were used in the

study. The experiment was conducted at the Eastern farm of Michael Okpara University of Agriculture Umudike (MOUAU). The location falls within latitude 05°2° N and longitude 07°32° E, with a nearly level to gently undulating topography and slopes ranging from 1% to 3%. The experiment was laid out as a split plot in a Randomized Complete Block Design (RCBD) with the main plots being the vegetable cowpea varieties, while four weeding regimes (no weeding (NW), weed free (WF), weeding once (WXI) and weeding twice (WX2)) occupied the sub-plots. The experiment was replicated three times. Each sub-plot measured 2 m × 3.5 m with 1 m alley between sub-plots and replicates. Two seeds were sown per hole on the flat at a spacing of 25 cm × 50 cm. Insect pest was controlled with *Cypermetherin* (EC) at 150 ml in 20-liters of water from bud initiation stage. Pre-cropping soil samples were randomly collected from four locations at 0 – 30 cm soil depth, and bulked together as composite soil sample. The soil sample was air dried in a room temperature for 48 hours, and subsequently sieved with a 2 mm sieve before being analyzed.

Growth data (plant height, numbers of leaves, number of branches, leaf area) were obtained at 4 and 8 weeks after planting (WAP). Number of fresh pods per plot was obtained by counting the number of pods from each plot at every harvest made twice a week from a 1m quadrant. Fresh pod yield/m^2 was obtained by harvesting the pods from 1 m quadrants at every harvest twice a week. Fresh and dry pod weights were obtained by weighing fresh/dry pods harvested per **m^2** with electric sensitive measuring scale. The average length of the pod was obtained by collecting 10 pods from each plot and determining their average length using a meter rule in centimeter. The numbers of seeds/pod extracted from dry pods collected from each plot was used for the calculation of 100 seed weight (g).

Results and Discussion

Initial soil test results

Results of the initial physico-chemical properties of the study soil showed that the study soil had a sandy clay loam texture, and a slightly acidic soil reaction (pH 5.0). Percentage total nitrogen was low (0.063%) with a moderate value of available phosphorus (19.35 mg/kg). Percentage soil organic matter was medium (1.272%).

Growth parameters

Average plant height

Results on plant height showed that plant height was very significantly ($P < 0.01$) influenced by variety at 4 and 8 WAP. Weeding regime and variety x weeding regime interaction did not significantly ($P > 0.05$) affect plant height at both 4 and 8 WAP (Table 2). Planting of IT04K-339-1 produced tallest plants (12.53 cm) which did not differ significantly with plant height (12.37 cm) of IT03K-324-9 at 4 WAP. However, at 8 WAP, variety IT99K-377-1 which recorded the lowest plant height (9.84 cm) at 4 WAP, returned the tallest plant (73.03 cm) that differed significantly only with plant height (52.58 cm) obtained from IT03K-324-9 variety (Table 1).

Average number of branches

Number of branches of vegetable cowpea was significantly ($P < 0.01$) affected by cowpea variety. Varieties ITO3K-324-9 and IT04K-339-1 recorded significantly highest number of branches (3.97 and 3.48, respectively), which did not differ significantly from each other. Lowest number of cowpea branches (1.95) was recorded by IT99K-377-1 variety at 4 WAP (Table 1). At 8 WAP, IT04K-339-1 maintained the highest number of branches (4.05), significantly over other varieties. Two varieties, ITO3K-324-9 and IT98K-692 suffered reductions in average number of branches at 8 WAP compared with number of branches recorded by the varieties at 4 WAP.

Average number of leaves

In terms of number of leaves, variety IT04K-339-1 recorded significantly ($P < 0.01$) highest number of leaves both at 4 WAP (11.94) and at 8 WAP (24.83) over all other varieties at 4 WAP and over IT99K-377-1 at 8 WAP. Variety IT99K-377-1 maintained lowest number of leaves at both 4 and 8 WAP.

Average leaf area

Average leaf area of vegetable cowpea was significantly ($P < 0.01$) influenced by variety at 4 and 8 WAP. Variety IT04K-339-1 recorded the highest leaf area (514.1 cm2) at 4 WAP, while IT99K-377-1 variety, which recorded the lowest leaf area (326.8 cm2) at 4 WAP, surpassed other varieties at 8 WAP by recording significantly highest leaf area (2271.3 cm2) (Table 1).

Weeding regime and variety x weeding regime interaction did not significantly ($P > 0.05$) influence any of the growth parameters measured

Yield and yield parameters

Fresh pod weight (t/ha)

The effects of variety, weeding regime and variety x weeding regime interaction on fresh pod weight (t/ha) of vegetable cowpea are as shown in Table 2. Variety and variety x weeding regime interaction did not significantly ($P > 0.05$) influence fresh pod weight. However, weeding regime very significantly ($P < 0.01$) influenced fresh pod weight of vegetable cowpea. All weeding regimes (weeding X1, weeding X2 and weed free) significantly yielded higher fresh pod weight than when vegetable cowpea was not weeded (No weeding (5.04 t/ha)). Optimum fresh pod yield (6.30 t/ha) was obtained from when weeding was carried out once (Weeding X1).

Number of seeds/pod and number of pods/m^2

Analysis of variance conducted showed that number of seeds/pod and number of pod/m^2 were highly significant ($P < 0.01$) among the varieties, while weeding regime did not show any significance ($P > 0.05$) for number of seeds/pod, but significantly ($P < 0.05$) influenced number of pods/m^2. Variety x weeding regime interaction did not significantly influence both parameters (Table 2). The results showed that variety IT99K-377-1 had the highest number of seeds (14.69/pod) while variety IT04K-339-1 had the least number of seeds (11.83/pod). Varieties IT98K-692 and IT03K-324-9 had the highest number of pods (158.75 and 138.42 pods/m^2, respectively) while variety IT99K-377-1 recorded the least number of pods (61.08 pods/m^2). The result also showed that optimum number of pods (107.50 pods/m^2) was obtained from plots that were weeded once, which did not differ significantly with values obtained from plots that were weeded twice (127.75 pods/m^2) and plots that were maintained weed free (124.33 pods/m^2).

100 seed weight (g) and pod weight (g) of vegetable cowpea

Results shown in Table 2 showed that 100 seed weight (g) and pod weight (g) among the vegetable cowpea varieties were highly significant ($P < 0.01$),while weeding regime and variety x weeding regime interaction did not significantly ($P > 0.05$) affect 100 seed weight and pod weight. Variety IT03K-324-9 had the biggest 100 seeds weight (18.24 g) among the vegetable cowpea varieties while variety IT98K-692 had the smallest 100 seeds weight (12.93 g). Significantly highest pod weights were obtained from varieties IT03K-324-9 (6.83 g) and 1T99K-377-1 (6.38 g), while variety IT04-339-1 had the smallest pod weight (4.73 g).

The result obtained in this study consistently showed that cowpea varieties, significantly influenced average plant height, average number of branches, average number of leaves, leaf area at 4 and 8 WAP, average number of seed/pod, number of pod/m^{2}and 100 seed weight (g). In terms of growth parameters, there were differences in varietal performance at different periods of observation. Variety 1T04K-339-1 showed consistency in improving plant height, number of branches, number of leaves and leaf area at 4 WAP. However, at 8 WAP, variety 1T99K-377-1 produced tallest plants with highest leaf area. It showed thatimprovements in growth parameters at 4 WAP by 1T04K-339-1 did not translate into improvement in yield parameters; instead variety 1T99K-377-1 which improved growth parameters at 8 WAP produced highest number of seeds/pod. Variety 1T03K-324-9, though it performed poorly in growth parameters, recorded the highest number ofpod/m^2 and highest 100 seeds weight. The study demonstrated that weeding is a critical farm operation that improved fresh pod yield (t/ha), while no weeding suppressed fresh pod yield (t/ha). Optimum number of pod/m^{2}was obtained when weeding was done once at 4 WAP (Weeding X1). It study identifies single weeding at 4 WAP as being most conducive for optimum yield of vegetable cowpea at Umudike. Reduction in number of pods/m^2 caused by increased length of weed interference (No weeding) was accompanied by a simultaneous reduction in fresh pod yield (t/ha). Similar result was reported by A L-Thaihabi*et al* (1994) in chickpea, where weed interference also caused reduction in number of pods and branches per plant and reduced seed size. The significant reduction in yield parameters obtained in weed free and weeding X2 regimes over the weeding X1 regime reflect the reduced effect of weed competition in weeded plots (Akobundu, 1978, Ojo, 1997).

Conclusion

Based on the results of this study, yield is maximized when weeding X1 regime is maintained throughout the life cycle of vegetable cowpea (*Vignaunguiculata L. walp*). Yield is also maximized under Umudike condition when variety 1T03K-324-9 is grown, despite its poor growth characteristics.

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Table 1: Effect of variety, weeding regime and variety x weeding regime interaction on growth parameters of vegetable cowpea grown on an Ultisol atUmudike

Treatment	**Plant height (cm)**		**Number of branches**		**Leaf number**		**Leaf area (cm²)**	
	4 WAP	**8 WAP**	**4 WAP**	**8 WAP**	**4 WAP**	**8 WAP**	**4 WAP**	**8 WAP**
Variety								
IT03K-324-9	12.37	52.58	3.97	3.00	9.91	21.14	280.1	1058.9
IT98K-692	10.18	61.13	3.28	2.61	9.63	20.48	403.6	1331.5
IT99K-377-1	9.84	73.03	1.95	2.83	6.51	17.36	326.8	2271.3
IT04K-339-1	12.53	71.09	3.48	4.05	11.94	24.83	514.1	1846.6
LSD (0.05)	1.32**	18.45**	0.66**	0.76**	1.29**	5.09**	62.8**	394.7**
Weeding regime								
Weed X1	10.96	62.40	2.85	3.03	8.94	19.81	359.5	1469.3
Weed X2	12.15	67.97	3.58	3.44	10.51	22.74	406.3	1663.0
Weed free	10.98	64.03	3.03	2.99	9.36	21.25	384.9	1609.4
No weeding	11.31	63.43	3.03	3.03	9.18	20.00	373.9	1766.7
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Variety x Weeding regime interaction								
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS

**** = Significant at 1% probability level; NS = Not significant at 5% probability level**

Table 2: Effect of variety, weeding regime and variety x weeding regime interaction on selected yield parameters of vegetable cowpea grown on an Ultisol atUmudike

Treatment	Fresh pod weight (t/ha)	Number of seeds/pod	Number of pods/m^2	100 seed weight (g)
Variety				
IT03K-324-9	8.19	12.61	138.42	18.24
IT98K-692	7.55	12.93	158.75	12.93
IT99K-377-1	3.72	14.69	61.08	15.70
IT04K-339-1	4.78	11.61	100.75	14.40
LSD (0.05)	NS	0.32**	21.0**	1.06**
Weeding regime				
Weed X1	6.30	12.82	107.50	15.55
Weed X2	6.50	13.10	127.75	15.66
Weed free	6.41	12.88	124.33	15.10
No weeding	5.04	13.03	99.42	14.96
LSD (0.05)	1.44**	NS	21.0**	NS
Variety x Weeding regime interaction				
LSD (0.05)	NS	NS	NS	NS

**** = Significant at 1% probability level; NS = Not significant at 5% probability level**

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Pesticides Application Practices Adopted by Cocoa Farmers in South-Western Nigeria

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Abstract
The wrong use of the pesticide application equipment in cocoa production has attracted a global concern about the impact of these pesticides on public health. Proper technique of pesticide application is very vital just as the selection of equipment, knowledge of pest behaviour and skilful dispersal methods. This study was aimed at assessing pesticide application practices and sprayer types adopted by cocoa farmers in South-western Nigeria towards ensuring minimum pesticide usage and appropriate choice of sprayer for different farm operation for sustainable cocoa production in the study area. A set of pre-tested questionnaire was used to collate information from farmers, while multistage sampling procedure was used to select 50 respondents each from two villages in Idanre Local Government of Ondo State and 45 respondents each from two villages also in Ogo-Oluwa Local Government Area of Oyo State. Results showed that 100% of the respondents make use of manually operated sprayer, while 55.9% uses knapsack sprayer. 74.7% of the respondent increased the frequency of application above the recommended rate while 68.4% increased dosage above recommended rate. 95.7% spray pesticide in the morning, 86.3% select a small-hole nozzle (low volume) for application and only 43% of the respondents ensure constant mixing of pesticide during operation. Most farmers apparently used spraying equipment and application practices based on what are at their disposal without basic knowledge and recourse to guiding principles for effective and efficient use of pesticide for controlling pests and diseases. It is recommended that for sustainable cocoa production, training and re-training of farmers on Good Agricultural Practices and Pesticides Usage is needed for efficient use of pesticide and choice of sprayer.

Keywords: application practices, pesticide, sprayer, farmers

Introduction
The nature of cocoa production has changed considerably over the last century, with enormous shifts, not only in how the crop is produced, but also where it is grown. Recent cocoa production has been relatively stable, but over longer periods, dramatic changes have occurred (Bateman, 2015). Nigerian cocoa production has suffered a major problem of pests and disease invasion. Most cocoa farmers are small-holders, who usually minimise inputs for pest and disease management, and may not be willing or able to invest their time or resources in any pest management when cocoa prices are low. However, pod diseases such as *Phytophthora megakarya* (black pod in West Africa) have the capacity to reduce yields by more than 80%. Farmers spray pesticides on a regular basis to contain the disease. Pesticide use in Nigeria has been on the increase since its introduction in the early 1950's for cocoa production. Many farmers believe that pesticides work, at least against some cocoa pest problems, and continue to use them depending on the pest and country (Bateman, 2015; Aikpokpodion *et al,* 2012). There are essentially two types of equipment commonly used for spraying cocoa trees: motorised mist-blowers (or air-blast sprayers) and manual (hydraulic) sprayers. Almost all small-holder farmers use manual (hydraulic) sprayers, which are globally the main method of pesticide (especially fungicide) application to cocoa. Motorised mist-blowers now have many uses, but they were originally developed for obtaining good droplet coverage in the tall cocoa trees of West Africa. For portable equipment (as used by most farmers and especially small-holders), specifications are given for sprayer tanks, pumps, etc., with specific requirements on nozzles. FAO envisaged

that member countries should put sprayer quality standards into law as with pesticides, but sadly, few countries have implemented this. Hydraulic nozzles remain the most widely used method of spraying chemical pesticides. They are fitted to a wide range of spraying systems ranging from the very basic hand-held 'trombone' sprayers, side-lever knapsack sprayers, compression sprayers (originally designed for vector control, but used by some cocoa farmers). There are guidelines on minimum equipment standards for manual sprayers that include various aspects relating to weight, durability, leakage, ease of cleaning and maintenance, instruction manuals, etc. (Bateman, 2015). Many manual sprayers used by smallholder cocoa farmers world-wide are fitted only with variable cone nozzles, and few farmers know which setting to use (Bateman *et al*., 2010). These sprayers are typically maintained by farmers themselves: although there have been Government or cooperative support initiatives. It can be difficult to convince smallholders that it usually pays in the long-term to choose a good quality, robust sprayer and always ask the question "Will I be able to find spare parts for it?" (Bateman, 2015). The wrong use of pesticide application equipment in cocoa production has attracted global concern about the impact of these pesticide on public health with respect to pesticide residue on cocoa and its products: problems of over-or-under-application include crop injury, poor pest control and injury to subsequent crop when using residual pesticide application practices (Malik *et al,* 2012; Takagi *et al,* 2012). Proper maintenance and storage of sprayers are very important for correct performance of pesticide application (Malik *et al*, 2012). The study was carried out to assess pesticide application practices and sprayer types among cocoa farmers.

Materials and Method

The study was carried out in Oyo and Ondo States. A multi-stage sampling procedure was used to select the sample for the study. In the first stage, Ondo and Oyo States were purposively selected due to their cocoa production records. Also, one Local Government Area (LGA) well noted for cocoa production was selected from each of the two states. Idanre and Ogo-Oluwa were selected from Ondo and Oyo States, respectively. Two villages were also chosen from each LGA. They are Owena and Onikokojiya from Idanre; Otamokun and Ibere from Ogo-Oluwa LGA. Fifty (50) and forty-five (45) cocoa farmers were selected from Idanre and Ogo-Oluwa LGA, respectively resulting in Ninety-five (95) farmers. A well-structured questionnaire was individually administered to ninety-five farmers (45 in Oyo and 50 in Ondo State). Data collected was analysed using descriptive statistics such as frequency counts and percentage. The variables considered include farmer's characteristics (age, sex, marital status, education and group membership) sprayer types and application.

Results and Discussion

Personal characteristics of cocoa farmers

Personal characteristics of farmers in the study area are described in Figure 1 to 3. Ages of farmers ranges between 20 and above 70 years. Those within the ages 20-50 years were relatively young being 57.9% of the total population studied while 42.1% were 51-90 years old (Fig. 1). The implication of this is that substantial percentage of farmers in South-western Nigeria was relatively old. This does not encourage sustainable cocoa production since most of the farmers were aging. More male (77.9%) were involved in cocoa production than female (data not shown). This was corroborated by Agbongiarhuoyi *et al,* (2013) in coffee production (that shares the same agroecology with cocoa). This is a good trend as men are regarded to be more energetic to handle herculean tasks such as land clearing better than women.

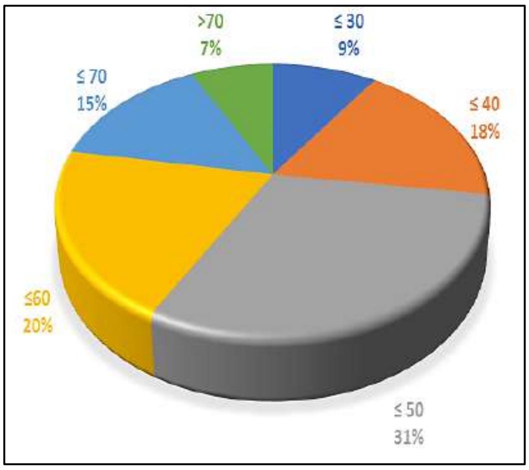

Figure 1: Age range of cocoa farmers

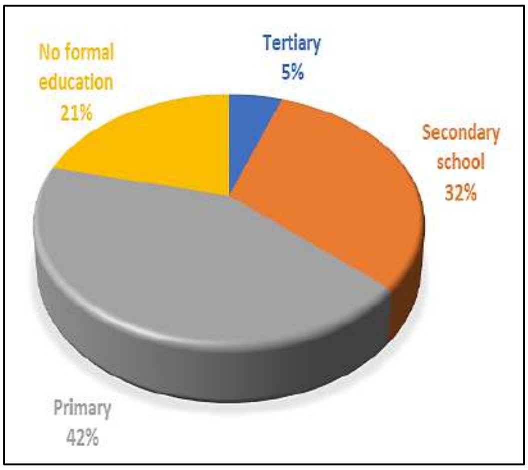

Figure 2: Educational status of cocoa farmers

The educational status of farmers is very important for interpreting and accepting new innovations and technologies in agriculture. However, very low percentage of farmers (5.3%) possessed higher certificates while 31.6% were holders of SSCE and substantial number of 21.0% had no formal education at all (Fig. 2). It had been reported that most of the cocoa farmers are not literate (Asogwa, 2008); hence they indulge in serious malpractices in pesticide application such as wrong use of nozzles, wrong formulations and doses, inability to distinguish one pest from the other and wrong timing of application. Education is positively associated with pesticide use, indicating that highly educated use more pesticides. It may be difficult for farmers without formal education to interpret, understand and accept information on new techniques in farming.

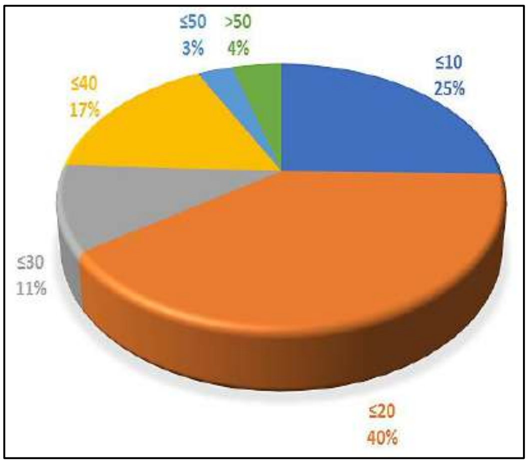

Figure 3: Farming experience (years)

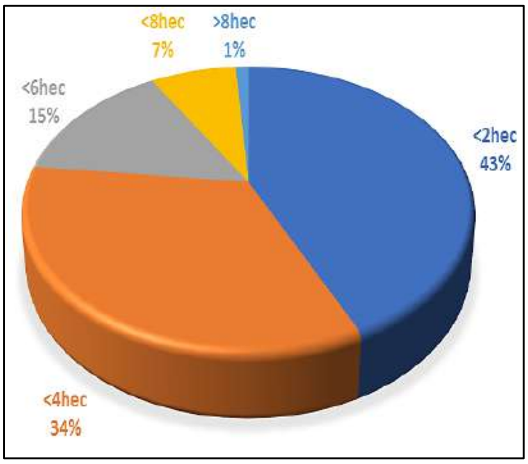

Figure 4: Size of cocoa farm (hectares)

Results showed that about 75% of the farmers sampled had more than 10 years farming experience (Fig. 3). This will help promote knowledge transfer and boost productivity. 76.8% of farmers had small area of farm between 0.1-4 hectares (Fig. 4). This is an indication that majority of cocoa farmers are incapacitated in one way or the other and should be encouraged to increase their farm size through provision of incentives.

Application practices

Significant number of respondent (56.8%) spray cocoa trees at 4-6 weeks' interval, 41% 1-3 weeks' interval while 1.1% sprayed before fruiting and on-setting of rain. Majority (71.6%) of the respondent followed the recommended label dose while 10.5% used fraction of recommended rate and 17.7% adopted indiscriminate pesticide usage. The implication of this is that most farmers are adopting approved pesticide application standards which will ensure quality cocoa beans for local and international market. It will also ensure minimum pesticide residue levels and promote good health for consumers of cocoa products. 86.3% of the farmers selected a low volume nozzle for spraying pesticides as against 5.3% that were indifferent about nozzle selection. Selecting correct spray nozzle type and size is essential for pesticide application (Malik *et al*, 2012). High Volume spraying, mostly obtained through hydraulic nozzles, is the most common and popular method of pesticide application; but Low Volume (LV) and Ultra Low Volume (ULV) are preferred for economic pest control. However, Asogwa *et al.*, (2009) reported that relative higher deposition of spray fluids on cocoa trees by the use of High Volume spraying compared with the use of Low Volume spraying by motorized mist blower in Ghana and fogging sprayers in the Cameroon accelerated the development of resistance. It may, therefore, imply that majority of cocoa farmers in the study area were using the appropriate nozzles for applying pesticides. Notwithstanding, Malik *et al,* 2012 stated that majority of the Nigerian Cocoa farmers still use substandard and inappropriate spraying pumps while attention was not paid to the use of appropriate jets and extension lances where recommended pumps were used. This trend is not encouraging for good pesticides spraying as high volume nozzles are recommended. Reasonably, number of farmers (95.7%) apply pesticides in the morning which is popularly acceptable while 4.3% were indiscriminate about choice of time. 44.2% half fill the tank with water before adding pesticide which is the acceptable method/practice, 20% of the farmers fill up the tank before adding pesticides, a total of 31.55% would either pour the pesticides and add water or mix separately in a container while 4.3% mix as convenient. This implies that a reasonable number of farmers are yet to understand the best procedure for mixing pesticides when loading the sprayer tank. Of the respondents only 43.5% take cognizance of important requirements like mixing the pesticide in the tank periodically after mounting the sprayer which ensures optimum results.

Table 1: Pesticide application practices

Variable	Frequency	Percentage
Spraying interval		
1-3 weeks	39	41.0
4-6 weeks	54	56.8
Before fruiting	1	1.1
Immediately rain set in	1	1.1
Pesticide concentration		
Recommended label dose	68	71.6
Fraction of label dose	10	10.6
Dose used by others	17	17.9
Nozzle selection for pesticides application		
Small hole (low volume)	82	86.3
Big hole (high volume)	6	6.3
Twin nozzle	2	2.1
Any type	5	5.3
Time of spraying pesticides		
Morning	91	95.7
Afternoon	-	-
Any convenient time	4	4.3
Methods of loading sprayer		
Fill-up tank with water and add pesticide	19	20.0
Half-filled tank with water and add pesticide	42	44.2
Pouring water and add water	14	14.7
Mix pesticide separately before pouring into tank	16	16.8
As it is convenient	4	4.3
Ensuring constant mixture of pesticide in the tank		
During operation		
Shaking immediately after mounting	41	43.1
Shaking periodically	43	45.3
Shaking at convenient time	9	9.4
Not necessary	1	1.1
None	1	1.1

Source: Field Survey, 2017

Relatively high number of respondents (74.7%) increased the frequency of pesticide application while 68.4% increased the dosage as a result of high level of infestation of diseases and pests (Table 2). This an attitude that does not support sustainable cocoa production in Nigeria. This corroborates Aikpokpodion *et al,* 2012 that indiscriminate use of pesticides by farmers without following manufacturer's instructions ultimately affects the quality of cocoa beans. It is noteworthy that European Union (EU) has set Maximum Residue Limit (MRL) for cocoa beans for consumption among her citizens (Bateman, 2015) which is considered important for exportation and safe local consumption of Nigerian cocoa beans. Higher percentage (64.7) of the farmers wait until there is a serious leakage from sprayer before rectification. Only 26.3% of the farmers always rectify sprayer leakages whenever it is observed in the flow line. This may be detrimental to spraying efficiency as well been injurious to farmers' health if keen attention is not paid to leakages and prompt rectification during spraying operation. Substantial number of respondent 22.1% and 42.1% did not understand the importance of precaution and maintenance of sprayer such as spraying in the direction of the wind and washing of sprayer before and after use. Lack of maintenance and mismanagement has been reported as one of the problems of pesticide application among Nigerian cocoa farmers (Asogwa & Dongo, 2009). Steps such as cleaning the sprayer and nozzle thoroughly after each use, using clean water and inlet net will ensure effective performance and prevent damage to subsequent crops sprayed and undesirable reaction between residual and new CPPs.

Table 2: Pesticide spraying intervals

Variable	Yes		Never		Occasionally		Always	
	Freq	%	Freq	%	Freq	%	Freq	%
Spraying interval								
Application of pesticide for pest and disease control	95	100	-	-	5	5.3	90	94.7
Do you increase the frequency of application during high infestation	71	74.7	24	25.3	51	53.7	20	21.0
Do you increase the dosage for high level of infestation	65	68.4	30	31.6	59	62.1	6	6.3
It is good to rectify leakage in the flow line of the sprayer only if it is serious	64	67.4	31	32.6	39	41.1	25	26.3
Spraying against the wind gives good result	21	22.1	74	77.9	21	22.1	-	-
Washing sprayer before and after use Is not important for good spraying result	40	42.1	55	57.7	34	35.8	6	6.3

Source: Field Survey, 2017

Conclusion

Most sprayer used by farmer are not suitable for the spraying of cacao but were adopted for use and this pose serious challenges to the health of farmers and eventual consumers of the produce. It is noteworthy that most farmers adopted the recommended dose as stipulated by the manufacturer. However, some of the farmers still lack good knowledge of the best practices for effective pesticide spraying this could probably be due to their low level of education on inadequate information on the right techniques of pesticide application and this implies that training and retraining of farmers is required on pesticides usage and the attendant health risks.
It is therefore recommended that efforts should be made by relevant bodies involved in the agrochemical business to engage in sensitization and training programme that will ensure the right choice of sprayer, strict adherence to safety precaution and optimum use of pesticides.

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Influence of Low and Sub-optimal Nitrogen Rates on Growth and Yield of Maize (*Zea mays* L.) Varieties on an Ultisol in Omoku, Rivers State, Nigeria

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Abstract
This study investigated the influence of low and sub-optimal nitrogen fertilizer rates on growth and yield of five maize (Zea mays L.) varieties on an ultisol in Omoku, Rivers State Nigeria. It was carried out at the Teaching and Research Farm of the Federal College of Education (Technical), Omoku; in the late cropping season of 2015 and early cropping season of 2016. Omoku lies on latitude 6° 40' E and longitude 5° 21' N in the tropical rainforest zone of South-South, Nigeria; its soil is classified as ultisols (regosols) of the typic kandiudult derived from the alluvial plain of the upper Sombreiro-Warri Delta. Varieties of maize planted were DMR-ESRY, Bende white, Mangu white, Oba super II and Oba super 4. Bende white and Mangu white are local varieties while DMR-ESRY, Oba super II and Oba super 4 are hybrids. The experiment was laid out in a Randomized Complete Block Design (RCBD) fitted into a split plot arrangement with three replications. The main plots were N- rates and the sub-plots were the five varieties of maize. Basal application of 30 kg P_2O_5 ha^{-1} as single super phosphate and and 15kg K_2O ha^{-1} as muriate of potash were done at at planting. N fertilizer was applied as urea in two equal split doses at 1WAP and 6WAP, respectively. Growth parameters collected were plant height and leaf area while, yield parameters were grain yield, cob length and 1000-seed weight. N-uptake of maize was determined by the formula: N content (%) x dry matter yield (kg ha^{-1}) / 100. Analysis of variance (ANOVA) was performed using PROC GLM on all the agronomic, yield and yield components identified above for each season using the Statistical Analysis Software (SAS) version 9.4. Treatment means were separated using the Fischer's protected Least Significant Difference (LSD) at $P < 0.05$. The least heights were obtained in the control plots while the highest heights were at 60 kg N ha^{-1}. Interaction between season and N-rates on plant height at 6WAP indicated that it was significant at $P < 0.05$. N uptake at the level of 60 kg N ha^{-1} was significantly higher than that obtained at 30 kg N ha^{-1} and control. There were significant differences among the five (5) varieties of maize at the different levels of N fertilizer application. Grain yield was similar to the level of N-uptake by each maize variety. Mangu white and Bende white performed better than the other varieties. It is recommended that urea fertilizer rate of 60 kg N ha^{-1} can be applied to maize cultivation on Omoku soil.
Key words: Growth, Maize, N-rates, N-uptake and Yield

Introduction
Maize (*Zea mays* L.) is a popular cereal crop grown in all agro-ecological zones of Nigeria. Its cultivation has increased in recent times and many scientific efforts have been put in place to increase its production. This increase in cultivation is occasioned by high demand in its usage for human consumption and industrial products. According to USAID (2010), maize is one of the three most important economically valued cereals grown in Nigeria along with sorghum and millet. It principally provides calories in human diet and animal feeds. In most Nigerian communities it is consumed as roasted or boiled cobs, breakfast cereal, pudding, soup or fermented paste, among others. Oladejo & Adetunji (2012) asserted that maize is a cereal plant that produces grains that can be cooked, roasted, fried, ground, pounded or crushed to prepare various food items like pap, "tuwo", "gwete", "dokunnu", and a host of others. These different

kinds of foods are available among the various ethnic groups in Nigeria such as the Yorubas, Hausas, Igbos, Ibiras, Ishan, Efiks, Binis, among others. The importance of this multipurpose cereal crop cannot be over emphasized as every part of its plant has economic value: the grain, leaves, stalk, tassel and cob can all be used to produce a large variety of food and non food products (IITA, 2009). Maize production requires high nutrients for its growth and yield. Among other soil nutrient required by the crop, nitrogen (N) plays a vital role in its metabolism and productivity. Although it is major nutrient required by plants, its level in the soil is often limited in supply because it is high volatile and readily leached (Anjorin, 2013). Several efforts have been put in place to checkmate this volatility and leaching potentials to enhance crop usage. One of such strategies is to select cultivars with high genotype for nitrogen use efficiency (NUE) under low soil nitrogen condition. This is achievable by the use of cultivars with superior N-use efficiency either by possessing a high N-uptake efficiency or enhanced N-utilization efficiency. Thus, under low soil N a maize variety with good performance should exhibit increase total biomass production, and plant height, leaf area and chlorophyll concentration, little affected by N deficiency, as well as, an efficient partitioning of biomass and n to the grain (Abe, *et al.,* 2013). It is against this backdrop that this study sought to evaluate the growth and yield performance of five maize varieties under low and sub-optimal N-rates on an ultisol in Omoku, Rivers State, Nigeria.

Materials and Methods

The experiment was conducted at the Teaching and Research Farm of Federal College of Education (Technical), Omoku Rivers State. Omoku is the headquarters of Ogba/Egbema/Ndoni Local Government Area (ONELGA) located on the North-Eastern fringe of Rivers State. Geographically, it lies on latitude 6°40´ East and longitude 5°21´ North in the tropical rainforest zone of South-South Nigeria. The soil of Omoku had been classified as Ultisol (regosols) of the upper Sombriero-Warri deltaic plain series (Ayolagha & Onuegbu, 2001). The dominant soil is typic kandiudult. The town which lies on an elevation of 17.69 m (58 feet) above sea level has two main seasons- rainy and dry seasons. The rainy season occurs between April – October with a bimodal pattern, ranging from 2040 to 3000 mm per annum. The break which occurs in August is commonly termed August break. The mean ambient temperature is 28.8°c with a maximum of 38.3°C with a relative humidity of 68 – 80% for large part of the year; the town has a monthly sunshine of 4.2 hours during the raining season. The experimental site was geo-referenced on these coordinates: Length 1 (L1): 05.37699^0 N, 006.67405^0 E; 05.37680^0 N, 006.67394^0 E and 05.37662^0 N, 006.67389^0 E. Width 1 (W1): 05.37662^0 N, 006.67389^0 E; 05.37658^0 N, 006.67398^0 E and 05.37657^0 N, 006.67406^0 E. Length 2 (L 2): 05.37657^0 N, 006.67406^0 E; 05.37673^0 N, 006.67418^0 E and 05.37695^0 N, 006.67424^0 E. Width 2 (W 2): 05.37695^0 N, 006.67424^0 E; 05.37696^0 N, 006.67413^0 E and 05.37699^0 N, 006.67405^0 E. The site located on a middle part toposequence (slope 0-2%), was well drained. The site had previously been under fallow for at least three years before the commencement of the experiment. The site was ploughed and harrowed two weeks after. The prepared site was marked out into plots and sub plots. The main plots measured 24 x 5m = 120m^2 while the sub plot measured 8 x 3m = 24m^2. Five cultivars of maize were obtained from the National Seed Service, Umudike near Umuahia, Abia State. The cultivars were DMR-ESRY, Bende white, Mangu white, Oba super II and Oba super 4. These cultivars have been marketed in Nigeria for sometimes, each having its own level of N requirement, either as N-sufficient or N-insufficient. The experiment was laid out in a randomized complete block design (RCBD) fitted into a split plot arrangement with three replications. The main plots were the rates of N-fertilizer (urea) while the sub-plots were the five maize cultivars. Each main plot had three levels of N-application labeled as no-N (control), low-N (30 kg N ha^{-1}) and sub-optimal - N (60 kg N ha^{-1}). Each level was separated from one another by 2.0 m to minimize possible movement of N from one treatment to another. There were fifteen sub-plots in each main plot. With three levels of N-application we had a total of 45 sub-plots in the entire experimental setup. At planting P in the form of single super phosphate and K as muriate of potash were based-applied at the rate of 30 kg P_2O_5 ha^{-1} and 15 kg K_2O ha^{-1} respectively. Three seeds of maize were planted per hole at a spacing of 0.75m x 0.50m and later thinned to two seedlings to maintained uniform number of plants in each sub-plot. Nitrogen fertilizer was applied in the form of urea in two split of equal doses, at one and six weeks after planting (WAP), respectively. The experiments were established on 29th August, 2015 and 16th April, 2016. Weeding was done manually twice with weeding hoe. Insect pests were controlled using the insecticide *lambdashi* applied through knapsack sprayer at 2l ha^{-1}. The field borders were kept clean to minimize encroachment by insects and rodents. The inner rows in each sub-plot were used for the destructive sampling. Prior to planting 20 top soil (0-15 cm) samples were randomly collected for routine analysis, using soil auger. The sampled soils were collected in a clean plastic bowl properly mixed to obtained composite sample. The composite sample was taken to the Agricultural Education laboratory of the Federal College of Education (Technical), Omoku where it was air dried, crushed and sieved through 2mm sieve to remove large particles, debris and stones. Routine soil analysis was carried out using the procedure described in the laboratory manual of the International Institute of Tropical Agriculture (IITA, 1989). Growth parameters , plant height and leaf area, were measured at 4 and 6 WAP, while N-uptake was measured at tasseling and harvest; and was determined by the formula: N content (%) x dry matter yield (kg ha^{-1}) / 100. Fresh biomass and dry matter (stover) weight on the other hand, were measured at tasseling while, cob weight, cob length, 1000-seed weight and total grain yield were measured at harvest. Analysis of variance (ANOVA) was performed using PROC GLM on all the agronomic, yield and yield components measured for each season using the Statistical Analysis Software (SAS) v 9.4 (SAS Institute, 2014). The treatment means were separated using the Fischer's protected Least Significant Difference (LSD) at $P<0.05$. The results obtained are presented in tables and bar charts.

Results and Discussion

Analysis of the pre-cropped soil indicates that it was slightly acidic (pH 6.10) with cation exchang capacity (CEC) of 7.90 Cmol kg^{-1} and effective cation exchange capacity of 8.01 Cmol kg^{-1}, medium total N (0.23%), organic carbon (2.13%) but high in available P (13.12 ppm) and very high percentage base saturation (98.63%). All of these indicate that the fertility of the soil was inherently moderate to high. The soil textural class was sandy soil (Table 1). Analysis of data generated from plant height at both 4WAP and 6WAP revealed that there were significant differences in the plant height in accordance with the N-rate of application. The least heights were obtained at the control while the highest heights were at 60 kg N ha^{-1}. At 6WAP the highest height was observed in Mangu white variety (Fig.2). This finding is in tandem with the report of Gul *et al.* (2015) who posited that nitrogen availability throughout the growing period of the crop is very important because, it is very essential for plant growth and make up 1 to 4 percent of dry matter of maize. Nitrogen being the major structural constitute of cells, as its level increases, the rate of vegetative and reproductive growth also increases in plants due to increase in assimilatory surface of plants as well as photosynthesis (Shrikanth *et al.,* 2015). From the foregoing it can be asserted that maize respond positively to N fertilizer application. So, at 60 kg N ha^{-1} the maize plants had more N to absorb hence their heights increased. The analysis of the leaf area was positively influenced by the N-rates of application. Leaf area was significantly influenced by the rate of N application. The finding that urea levels increases the leaf area of maize plants is in agreement with the study of Olowoboko *et al.* (2017) who asserted that leaf area of increased with N application rate of 120 kg ha^{-1} and a decrease was recorded for the control. Also, Anjorin (2013) reported that nitrogen fertilizer had significant effect on plant height, leaf area, number of kernels per cob, weight of 100 grains and grain yield. Nitrogen (N) uptake of the maize cultivars at tasseling stage and harvest is presented in Fig. 3. The result revealed that N uptake in the five maize cultivars increased with the level of application of N fertilizer from 0 to 60 kg N ha^{-1}. Uptake in plots applied with 30 and 60 kg N ha^{-1} were significantly higher than the control, while the uptake in 60 kg N ha^{-1} was significantly higher than 30 kg N ha^{-1}. It was also observed that N uptake levels differ significantly among the five varieties of maize at the different levels of urea application. Bende white was significantly higher in the N uptake at tasseling than the other varieties. That was followed by DMR-ESRY, Mangu White, Oba Super II and Oba Super 4 respectively. Similarly, grain yield of the maize varieties (Fig.4) was significantly different in accordance with N-rates. The least grain yields were obtained in the control while the highest grain yields were gotten in plots treated with 60 kg N ha^{-1}. The result of the interaction between the varieties and N rate revealed that it was significant at $P < 0.05$, indicating that at least the yield of one variety of maize was influenced by the rate of N application. The local varieties of Mangu white and Bende white performed better in terms of grain yield than the hybrids across the various seasons of the experiment. This may be caused by their less desire for more nitrogen than the hybrids. The observation that the hybrid varieties of DMR-ESRY, Oba super II and Oba super 4 could not yield as much as the local varieties of Mangu white and Bende white, could be attributed to their desire for more nitrogen application. It has been argued that maize hybrids need more nitrogen than the local varieties. This finding is in agreement with the report of Onasanya *et al.* (2009) that the results of various fertilizer experiments carried out in Nigeria showed that hybrid maize cultivars were found to require high fertilizer rate for optimum yield. Analysis of variance further indicated that there was significant different in the yield components of cob lengths and 1000-seed weight at the rates of N application (Figs.5-6). Maize grain yield depends on the yield contributing characters As it were, the weight of 1000-seed increased with the rates of urea application throughout the seasons of the experiment. This implies that the weight of 1000-seed of maize was significantly influenced by the N rates. This finding is in agreement with the observation of Ahmad *et al*. (2018) who posited that thousand grain weights of maize were significantly affected by cultivars and nitrogen levels. This finding is also consistent with the finding of Hokmalipour & Darbandi (2011) who reported that 1000-grain weight was affected by cultivars and nitrogen levels.

Conclusion

The results of this study show positive relationship between N-rates and growth and yield of maize varieties. Application of 60 kg N ha^{-1} significantly enhanced better plant growth and yield of all maize varieties planted. Among the varieties of maize used in the study, the local varieties of Mangu white and Bende white performed better than the hybrid varieties of DMR-ESRY, Oba super II and Oba super 4. It is therefore recommended that urea fertilizer rate of 60 kg N ha^{-1} can be applied to maize cultivation on Omoku soil.

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Table 3.1 Physico-chemical properties of soil (0-15cm) of the experimental site prior to cropping.

Soil parameter	Value
pH(H_2O)	6.10
Exchangeable cations (Cmol kg^{-1})	
Ca	5.50
Mg	2.08
Na	0.21
K	0.11
Exchangeable acidity (Cmol kg^{-1})	0.11
Effective CEC (Cmol kg^{-1})	8.01
Cation exchange capacity (Cmol kg^{-1})	7.90
Base saturation (%)	98.63
Org. C (%)	2.31
Total N (%)	0.23
Avail. P (ppm)	13.12
Micro-nutrients (ppm)	
Cu	1.10
Mn	8.35
Fe	250.00
Zn	4.55
Particle size distribution (%)	
Sand	91.00
Clay	5.60
Silt	3.40
Textural class	sandy soil

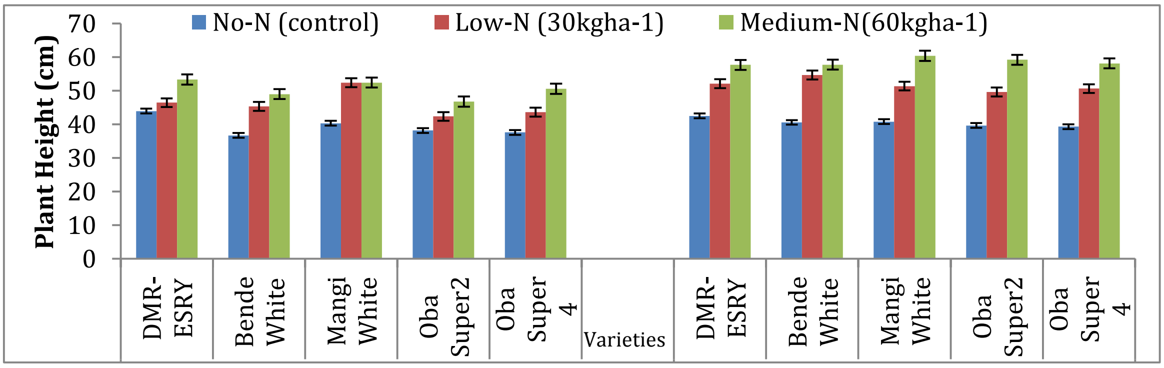

Fig. 1: Plant height of various varieties of maize 4 WAP at Omoku

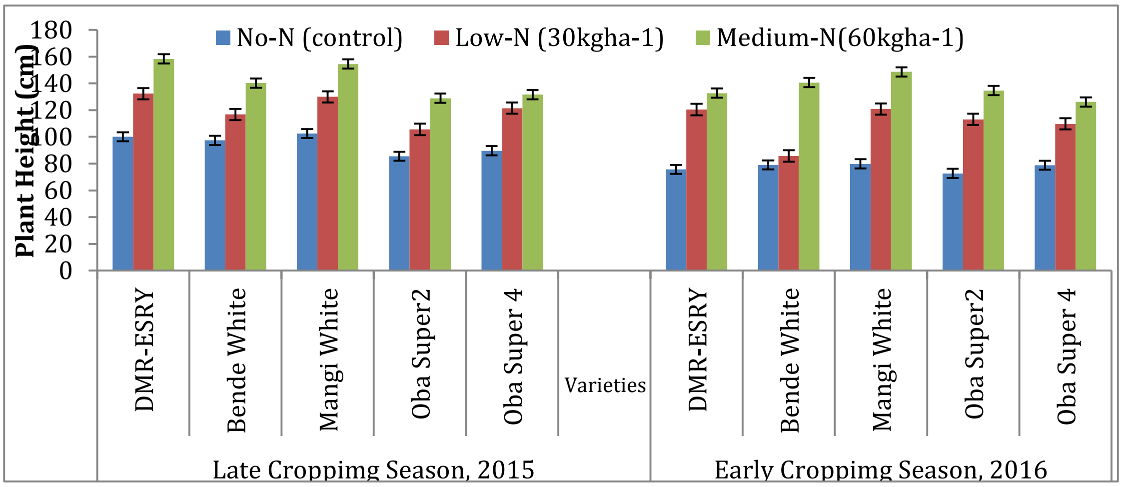

Fig. 2: Plant height of various varieties of maize 6WAP at Omoku

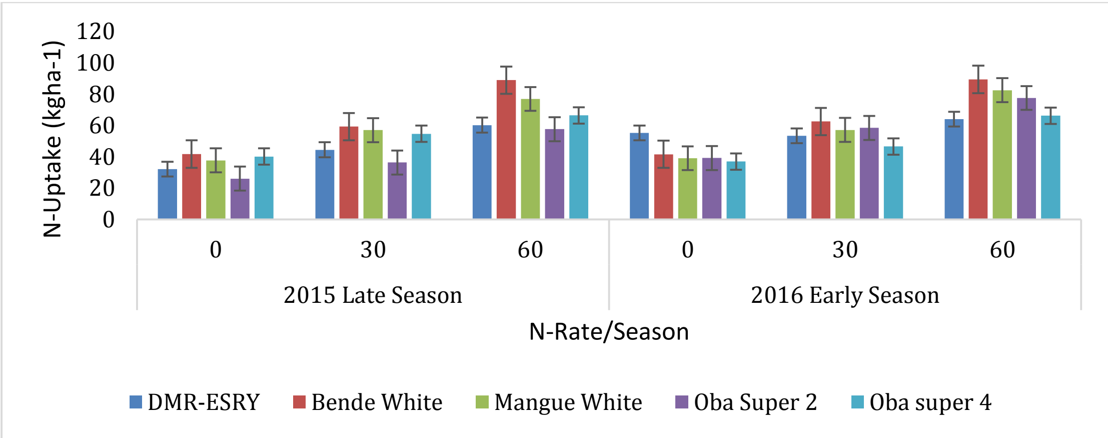

Fig. 3: N uptake at harvest in early and late seasons

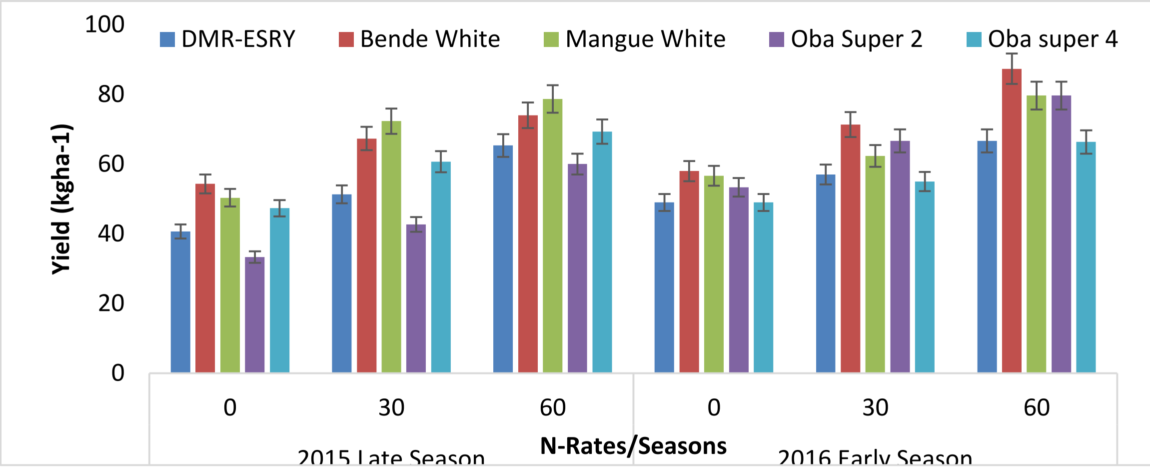

Fig. 4: Yield at harvest in early and late seasons

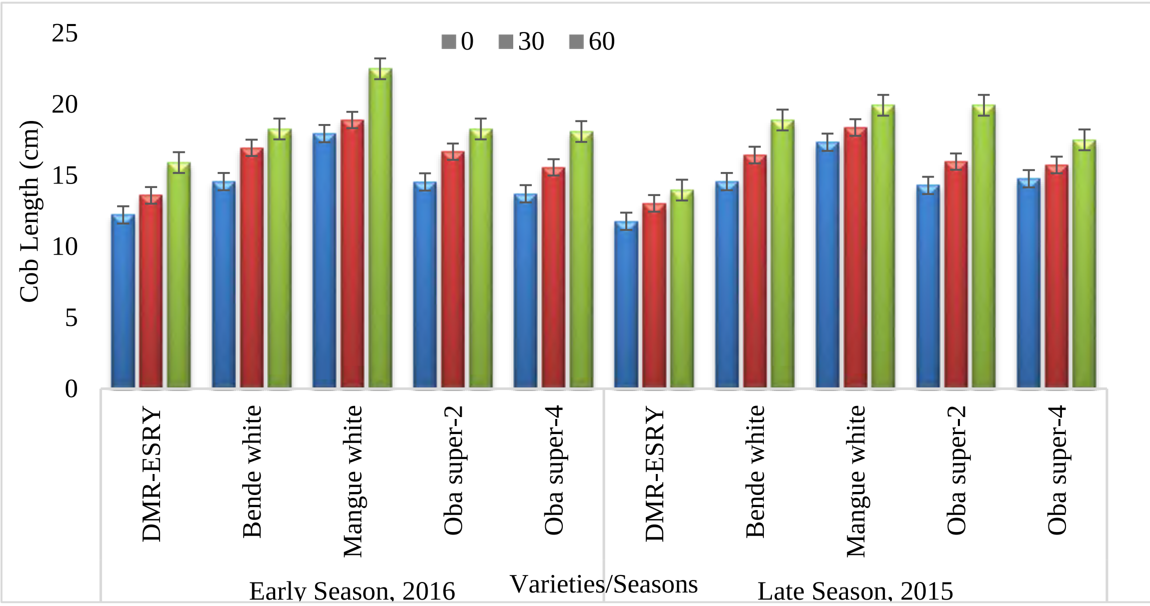

Fig. 5: Influence of N-rates on cob length of maize in Omoku

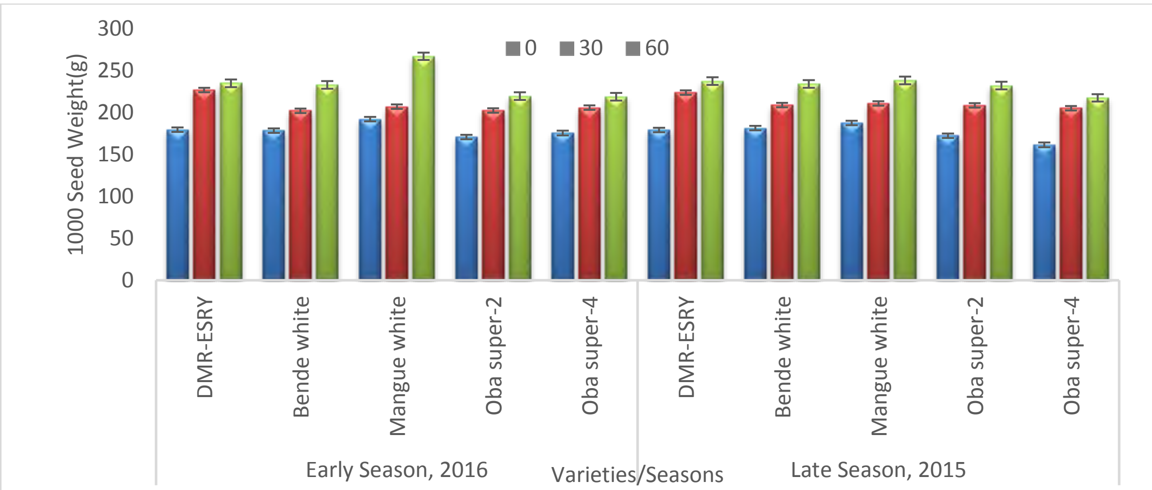

Fig.6: Influence of N-rates on 1000 seed weight of maize in Omoku

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Modes of Inheritance of Late leaf Spot in Groundnut (*Arachis hypogaea* L.)

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Abstract

Late leaf spot (LLS) Phaeoisariopsis personata (Berk. and Curtis) Deighton is one of the most important foliar diseases of groundnut worldwide including Nigeria. Repeated application of fungicide could contribute to greater production cost and environmental pollution. The deployment of resistant cultivars offers a better option for the management of the disease in groundnut. Information on the genetic control of resistant to LLS will aid in the development of appropriate breeding methodology that will result in the development of resistant genotypes with high yielding potentials. The objective of this study was to determine the mode of gene action controlling LLS in some groundnut genotypes. Nine parental groundnut genotypes comprising of five LLS resistant (ICGV 12991, ICGV 7878, FDR-F7 82, FDR-F7 67 andß FDR-F7 61) and four LLS susceptible (SAMNUT 23, SAMNUT 24, SAMNUT 25 and SAMNUT 26) genotypes obtained from IAR were used to generate F_1 hybrids using 4 x 5 North Carolina design II mating design. The 20F_1s and the parental genotypes were evaluated for LLS in a randomized complete block design with three replications at the screen house of the Department of Plant Science under artificial inoculation. High relative humidity was maintained by covering the plants with polyethylene bags for 24 hours before and after inoculation. Data were collected on pod yield, disease severity, disease incidence and other agronomic traits. The results of the analysis of variance indicated highly significant ($P \leq 0.01$) differences for the traits of the genotypes evaluated. Negative GCA effects were recorded for disease incidence in SAMNUT 25 (-0.05), indicating the genotype is a good general combiner for LLS disease incidence. The ratio of the GCA and SCA variances indicated the preponderance of SCA variance over GCA variance for disease incidence and severity, indicating the role of non-additive gene effect and it may be due to difference in genotypes used as parents. Hence, selection has to be delayed to when the gene for LLS is fixed.

Keywords: Late leaf Spot, GCA and SCA

Introduction

The cultivated groundn0ut (*Arachis hypogaea* L.) is an important food legume highly adapted to tropical and subtropical climates of the world. It is grown primarily as an oil crop, and largely grown in over 100 countries, with a world total production of 43.98 million tons on 21.8 million hectares (FAO, 2016). In West Africa, Nigeria is the largest producer of groundnuts with production of 3.0 million tons on about 2.4 million hectares (FAO, 2016). Groundnut is valued as a rich source of energy whose oil content stood at 48–50% and protein 25–28% in the kernels (Janila *et al.*, 2013). The cake obtained after extraction of oil is used in animal feed industry, infant feed preparation and as soil amendment as it resist lead absorption (Liu and Nie, 2013). Despite the socio-economic and cultural importance of groundnut, its productivity in Nigeria is below 1 ton/ha because of number of abiotic (droughts) and biotic (especially due to pests and diseases) stresses (Reddy *et al.,* 2003). Late leaf spot is the most devastating fungal disease accounting for yield loss of over 60% (Okello *et al.*, 2010). The disease is caused by *Phaeoisariopsis personata* with symptoms that are seen as small necrotic flecks that enlarge and become light to dark brown. Previous studies have shown that efforts have been made to control late leaf spot disease using a combination of cultural and chemical measures with limited success (Page *et al.*, 2002). Use of fungicides to control leaf spots usually increases production costs by

10% (Coffelt and Porter, 1986). Effective chemical control is heavily reliant upon multiple fungicide applications (Jordan *et al*., 2012) that are costly for resource poor farmers in Nigeria, and as well raises environmental and health concerns with a significant decrease in crude protein and fiber contents with increasing disease severity (Coffelt and Porter, 1986). These factors coupled with health hazards associated with the use of insecticides suggested the use of host plant resistance as the most effective and environmentally friendly control measure for the management of LLS. Genetic information on inheritance of LLS will help in the development of LLS resistant cultivars that will reduce production costs and boost groundnut production in Nigeria. The objective of this study therefore was to determine the mode of gene action controlling late leaf spot resistance in groundnut genotypes.

Materials and Methods

The research was conducted at the Institute for Agricultural Research (IAR), Samaru, Ahmadu Bello University, Zaria ($11^0$11'N, $07^0$38'E), 600m above sea level in the Northern guinea Savannah. The research was carried out during the 2015/2016 raining season.

Experimental Materials: The experimental materials for this study comprised of nine early maturing groundnut genotypes representing a range of resistance levels to Late Leaf Spot (LLS) obtained from IAR Samaru. The resistant genotypes were validated in the 2013/2014 growing season IAR at the farm, Samaru. Five genotypes: ICGV 12991, ICGV 7878, FDR-F7 82, FDR-F7 67 and FDR-F7 61 were resistant to Late Leaf Spot (LLS and four others: SAMNUT 23, SAMNUT 24, SAMNUT 25 and SAMNUT 26 were commercially grown genotypes developed by IAR, which were susceptible to the Late Leaf Spot.

***Population Development*:** Two seeds from each of the groundnut genotypes were sown in plastic pots measuring 50.91m^3 in June 2015. The susceptible genotypes were used as female parents while the resistant genotypes as male parents. The parents were crossed in a 4 x 5 North Carolina mating design II as described by Comstock and Robinson (1948) to generate 20 F_1 progenies.

***Evaluation of F_1 for response to LLS*:** The 20 F_1 progenies and the 9 parents were evaluated for LLS in the screen house using randomized complete block design (RCBD) with three replications. Two pots were allocated for each genotype and two seed were sown per pot. Agronomic practices; weeding; was carried out three times, fumigating; was done once, watering; were carried out to ensure proper growth and development of the groundnut genotypes.

***Inoculation*:** Inoculum was obtained from groundnut leaves infected with LLS collected from IAR field. Fungal isolation was done using scheduled isolation trials at the IAR groundnut farm as described by (Riker and Riker, 1936; Khan *et al.,* 2013). The diseased portion of leaves was cut into small pieces of 1-2 mm and surface sterilized with 0.1% mercuric chloride solution for 1-2 minutes. The small pieces were rinsed twice in sterilized water and transferred to sterilized paper in petri dishes for drying. Plating of these dried pieces was done on Petri plates containing potato dextrose agar (PDA) medium in a laminar hood. The petri plates were then incubated at $27^oC\pm2^oC$ for 57 days to allow the fungi to grow. After five days the margins of the developed mycelium were sub-cultured on PDA at 25^oC for seven days to get the pure culture of LLS. Single spore method was used for the identification of the LLS on the basis of morphological characters. Mycelial growth of the LLS in petri plates was blended with sterilized distilled water in a blender. Numbers of spores were diluted with sterile distilled water to reach 3.3×105 CFU ml^{-1}. The spores were used as inoculum, which was sprayed on all the treatments except control. To provide favorable environment for disease development, watering was carried out regularly (Ijaz, 2011). Thirty-five days old plants were inoculated with LLS at 106 conidia/ml inoculum concentrations. Hand held sprayer was used for the inoculation; 0.1 ml spore suspension was dropped on the leaves. High relative humidity around the plants was maintained by covering the plants with wet polythene bags 24 hours before inoculation. Inoculated plants were covered for another 24 hours to maintain high humidity. Plants were observed weekly for development of disease after inoculation and disease score was recorded using 1-9 scale describes by Subrahmanyam *et al*. (1995).

***Percent disease incidence* (PDI):** PDI scale for groundnut LLS of less than 10% are highly resistant), 11-30% (Resistant), 31-50% (Moderately resistant) and More than 50% (Susceptible)

Data collection: Data were collected on number of mature pods per plant, number of seeds per pod, LLS disease severity at 65 and 90 days after sowing (DAS) as described by Wambi (2014) using a modified nine-point scale as described by Subrahmanyam *et al*. (1995) as showed in

Table 1 and **LLS** disease incidence; The per-cent disease incidence was scored using the scale recommended by ICRISAT (Waliyar *et al*., 2007)

Data Analysis: Data collected on disease severity and incidences were transformed using log10 and were all subjected to analysis of variance and estimates of genetic effects were obtained using General Linear Model procedure of Statistical Analysis System (SAS) package (SAS, 2002). Broad sense (H^2) and narrow sense (h^2) heritability were estimated from broad sense (H^2) and narrow sense (h^2) heritability (Kearsey and Pooni, 1996). (Kearsey and Pooni, 1996). The heritability values were categorised as low, moderate and high as suggested by Robinson *et al.* (1949), where 0 - 30% (Low), 30-60% (Moderate) and >60% (High).

Results and Discussion

Analysis of Variance for Late Leaf Spot

The mean squares from analysis of variance showed highly significant ($P \leq 0.01$) differences among the genotypes for all traits evaluated in this study (Table 1). The presence of highly significant difference suggests the existence of sufficient variability in the material used and provide opportunity for improving groundnut for LLS resistance. The amount of improvement that can be achieved by selection among a number of crosses is dependent on the amount of variation between the crosses. The crosses between SAMNUT 23 x ICGV 7878, SAMNUT x FDR-F7 67 and SAMNUT 24 x FDR-F7 82 showed tolerance to LLS disease incidence ( ) with low severity ( ). This result corroborated with the findings of John *et al*. (2008) who reported moderate incidence of LLS in F_2 population of the Kadiri-3 × ICGV-88083, confirming the possibility of transferring the LLS traits in groundnut.

Mean performance of the genotypes

The mean performance of groundnut genotypes studied for late leaf spot and other agronomic traits are presented in Table 2. Disease severity among the parents; FDR-F7 61 with 19% on a score of 4 (lesion on the lower middle leaves, but severe on lower leaves, defoliation of some leaflets evident on lower leaves), SAMNUT 26, ICGV 12991, ICGV 7878, FDR-F7 82, FDR-F7 67 with 21- 30% on a score of 5 (lesion on lower and middle leaves, over 50% defoliation of lower leaves), SAMNUT 25 with 40% on a score of 6 (lesion severe on lower and middle leaves, defoliation of some leaflet evident on middle leaves), SAMNUT 23 with 42.7% on a score of 7 (lesion on all leaves but less severe on top leaves, defoliation of all lower and some middle leaves). Among the crosses, SAMNUT 24 x FDRF7 82, SAMNUT 24 x FDRF7 61,SAMNUT 25 x FDR-F7 82, SAMNUT 26 x ICGV 12991, SAMNUT 26 x FDR-F7 82 and SAMNUT 26 X FDR-F7 61 with 21-30% on a score of 5 (lesion on lower and middle leaves, over 50% defoliation of lower leaves), and SAMNUT 24 x ICGV12991 and SAMNUT 25 x FDR-F7 61 with 41- 60% on a score of 7 (lesion on all leaves but less severe on top leaves, defoliation of all lower and some middle leaves). Generally, there were wide variations were observed for disease severity.

General combining ability (GCA) effects

The estimates of GCA effects of male and female parents for some agronomic traits and groundnut genotypes are presented in Table 3. Results indicates that ICGV12991, FDR-F7 82 and FDR-F7 61 have significant GCA variance for number of matured pods, and seeds, in addition the exhibited negative GCA variances for disease incidence and percent disease severity. This is confirming that these male parents are truly resistant to LLS and therefore justified their use as a source of pollen for development of LLS resistant groundnut varieties. Among the female parents, only SAMNUT 23 and SAMNUT 24 showed variation in susceptibility to LLS with significantly positive GCA variance for percent DI and DS (11.93 and 6.00, respectively). The other two parents; SAMNUT 25 and SAMNUT 26 however, depicted significantly negative GCA variance for LLS.

Specific combining ability (SCA) effects

The specific combining ability (SCA) effects for some agronomic traits and Late Leaf Spot of groundnut genotypes are presented in Table 4. Negative and significant SCA effects for disease incidence were exhibited by SAMNUT 25 x FDR-F7 67 (-0.08) and SAMNUT 24 x FDR-F7 61 (-0.10). SAMNUT 23 x ICGV 12991 (-0.74), SAMNUT 24 x FDR-F7 82 (-0.12), SAMNUT 24 x FDR-F7 67 (-0.09), SAMNUT 24 x FDR-F7 61 (0.11), SAMNUT 25 x ICGV 7878, SAMNUT 25 x FDR-F7 67, SAMNUT 26 x FDR-F7 67 (-0.08) while SAMNUT 26 x ICGV 7878 (-0.13) showed a negative significant SCA effects for disease severity. The progenies with negative SCA effects for disease incidence and disease severity SAMNUT 24 x FDR-F7 61 and SAMNUT 25 x FDR-F7 67 were identified as the most promising genotypes in breeding programme for LLS tolerance traits. These progenies originated from parents with negative and positive GCA values. This suggest the difficulty in predicting the *P. personata* tolerance level of the progenies based on GCA alone and should necessitate testing of specific male x female combinations. Arunga *et al.* (2010) reported that the SCA effect alone has limited value for parental choice in breeding programmes. They, therefore suggested that SCA effects should be used in combination with other parameters, such as hybrid means and the GCA of the respective parents such that hybrid combination with both high mean and favourable SCA estimates and involving at least one of the parents with high GCA, would tend to increase the concentration of favourable alleles; which is desired by any breeder.

Conclusion

The study revealed ample genetic variability for the agronomic traits in the parents used for the study. Both additive and non-additive gene actions were important in controlling the inheritance of LLS. There was however, the preponderance of non-additive gene action to the inheritance of LLS, therefore selection for LLS resistant has to be delay to further generation whenvthe genes are fixed.

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Table1: Mean squares from ANOVA of groundnut genotypes for agronomic traits and late leaf spot evaluated at Samaru in 2016

Source	Df	Number of mature Pod per plant	Number of seed Per pod,	Disease incidence	Disease Severity
Replication	2	0.33	0.01	0.06**	0.08**
Genotype	28	29.25**	0.18**	0.03**	0.03**
Error	56	0.81	0.01	0.00	0.00

Table 2: Mean performance of 29 groundnut genotypes evaluated for some agronomic traits and late leaf spot at Samaru in 2016

GENOTYPE	MPPP	SPP	DI (%)	DS (%)
Parents				
SAMNUT 23	8.33	1.37	61.7(1.79)	42.7(1.63)
SAMNUT 24	18.67	2.10	55.0(1.74)	35.3(1.54)
SAMNUT 25	7.67	1.77	48.3(1.68)	40.0(1.52)
SAMNUT 26	12.00	1.83	35.0(1.52)	25.2(1.38)
ICGV12991	12.33	1.87	33.3(1.51)	24.9(1.39)
ICGV7878	8.33	1.80	40.0(1.60)	27.7(1.44)
FDR-F7 82	8.67	1.80	33.3(1.52)	23.4(1.37)
FDR-F7 67	13.67	2.17	31.7(1.50)	21.5(1.33)
FDR-F7 61	9.67	2.17	26.7(1.42)	19.0(1.28)
Crosses				
SAMNUT 23 x ICGV12991	8.06	1.79	50.0(1.74)	38.9(1.63)
SAMNUT 23 x ICGV7878	12.88	1.74	45.0(1.64)	31.8(1.48)
SAMNUT 23 x FDR-782	9.37	1.88	50.0(1.73)	32.8(1.55)
SAMNUT 23 x FDR-F767	12.70	1.91	46.7(1.66)	33.6(1.54)
SAMNUT 23 x FDR-F761	7.23	1.84	51.7(1.72)	36.5(1.56)
SAMNUT 24 x ICGV12991	15.91	1.77	60.0(1.74)	42.4(1.57)
SAMNUT 24 x ICGV7878	17.90	1.90	51.7(1.69)	37.7(1.56)
SAMNUT 24 x FDR-F782	9.22	1.50	40.0(1.61)	27.7(1.42)
SAMNUT 24 x FDR-F767	6.74	1.71	45.0(1.66)	31.8(1.52)
SAMNUT 24 x FDR-F761	10.00	1.35	35.0(1.54)	25.2(1.38)
SAMNUT 25 x ICGV12991	13.17	1.93	56.7(1.77)	40.2(1.61)
SAMNUT 25 x ICGV7878	11.16	1.61	60.0(1.79)	40.6(1.61)
SAMNUT 25 x FDR-F782	7.56	1.90	41.7(1.60)	28.1(1.44)
SAMNUT 25 x FDR-F767	8.27	1.15	41.7(1.64)	31.1(1.49)
SAMNUT 25 x FDR-F761	8.71	0.97	63.3(1.80)	42.7(1.63)
SAMNUT 26 x ICGV12991	13.62	1.87	53.3(1.72)	38.0(1.58)
SAMNUT 26 x ICGV7878	10.21	1.80	41.7(1.60)	28.1(1.44)
SAMNUT 26 x FDR-F782	9.60	1.54	38.3(1.59)	27.4(1.44)
SAMNUT 26 x FDR-F767	12.94	1.40	51.7(1.73)	38.0(1.59)
SAMNUT 26 x FDR-F761	13.90	1.81	40.0(1.57)	26.2(1.41)
MEAN	10.89	1.72	45.8(1.65)	32.2(1.50)
LSD	1.47	0.16	10.4(0.10)	7.0(0.09)
CV	8.27	5.87	3.55	3.83

Table 3: Estimates of General combining ability effects of groundnut genotypes evaluated for some agronomic traits and late leaf spot at Samaru in 2016

GENOTYPE	MPPP	SPP	DI (%)	DS (%)
Males				
ICGV12991	-0.50	-0.13**	-0.01	-12.00**
ICGV 7878	-1.12**	0.10**	0.01	2.08**
FDR-F7 82	1.22**	0.02	-0.02	0.83**
FDR-F7 67	-1.25**	-0.19**	0.04*	-0.68**
FDR-F7 61	1.15**	0.08**	-0.03	-2.23**
SE±	0.25	0.02	0.02	0.02
Females				
SAMNUT 23	0.33	0.13**	0.06**	11.93**
SAMNUT 24	2.25**	0.13**	0.01	6.00**
SAMNUT 25	-1.75**	-0.02	-0.05**	-0.02
SAMNUT 26	-0.33	-0.12*	-0.01	-5.90**
SE±	0.28	0.03	0.02	0.02

Table 4: Estimates of Specific combining ability effects of groundnut genotypes evaluated for some agronomic traits and late leaf spot at Samaru in 2016

CROSSES	Number of Mature pod per plant,	Number of Seed per pod	Disease sever (%)	Disease incidence
SAMNUT 23 x ICGV12991	-3.80**	-0.25**	-0.04	-0.74**
SAMNUT 23 x ICGV7878	0.95	-0.02	-0.05	0.22**
SAMNUT 23 x FDR F782	1.28*	0.00	0.06	0.13**
SAMNUT 23 x FDR F767	3.53**	0.16**	0.00	0.19**
SAMNUT 23 x FDR F761	-1.97**	0.11*	0.04	0.20**
SAMNUT 24 x ICGV12991	2.53**	0.02	0.06	0.34**
SAMNUT 24 x ICGV7878	3.62**	0.05	0.04	-0.01
SAMNUT 24 x FDR F782	-0.72	-0.10*	0.00	-0.12**
SAMNUT 24 x FDR F767	-4.47**	0.14*	0.00	-0.09*
SAMNUT 24 x FDRF761	-0.97	-0.11*	-0.10*	-0.11*
SAMNUT 25 x ICGV12991	1.33*	0.23**	-0.03	0.22**
SAMNUT25 x ICGV7878	-0.92	-0.10*	0.06	-0.08*
SAMNUT 25 x FDR F782	-0.25	0.28**	-0.04	-0.06
SAMNUT 25 x FDR F767	-0.67	-0.22**	-0.08*	-0.08*
SAMNUT 25 x FDR F761	0.50	-0.20**	0.09*	-0.01
SAMNUT 26 x ICGV12991	-0.07	0.00	0.01	0.18**
SAMNUT 26 x ICGV7878	-3.65**	0.07	-0.04	-0.13**
SAMNUT 26 x FDR F782	-0.32	-0.18**	-0.01	0.05
SAMNUT 26 x FDR F767	1.60*	-0.08	0.08	-0.02
SAMNUT 26 x FDR F761	2.43**	0.20**	-0.03	-0.08*
SE±	0.57	0.05	0.04	0.04

* and ** = significant at 0.05 and 0.01 probability levels respectively

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Heavy Metal Characteristics of Leaf And Tuber of Cassava (*Manihot esculenta Crantz)* Grown oon Crude Oil Contaminated Soil With Rumen-Based Waste Augmentation

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Abstract
In this field study conducted at the Teaching and Research Farm of Department of Agricultural Education, Federal College of Education(Technical) Omoku, Rivers State Nigeria to determine the bioremediation potentials of rumen- based wastes (RBW) on crude oil polluted soils, Cassava (Manihot esculenta Crantz.) was used as test crop. The soil was contaminated with Bonny Light crude oil obtained from OB/OB Nigeria Agip Oil Plc. Fresh RBW was obtained from an abattoir in Omoku, Rivers State. Cassava stems were obtained from the NAOC Green River Project, Obrikom. The soil was pulverized, made into raised seed beds, then contaminated with crude oil at the rates of 0litre m^{-2}(Control), 1.5litre m^{-2} (Mild), 3litre m^{-2} (Moderate) and 4.5litre m^{-2} (Severe). Two weeks after contamination RBW were applied as mulches at the rates of 0, 2, 4 and 6kg/m^{-2}. Results show that RBW increased nickel, lead and copper accumulations in cassava leaf and tuber. It is recommended that RBW should not be used in augmenting crude oil polluted soils as it enhanced accumulation of heavy metals in cassava leaf and tuber.
Keywords: Augmentation, Crude oil, Heavy metal, Remediation and Rumen-based waste

Introduction
The environment which can be described as the world around us is constantly under threat due to various human activities. Natural processes such as earthquakes, floods, tsunamis, drought, and volcanic eruptions pollute and degrade the environment, but human activities are the greatest culprits and drivers of environmental degradation. A typical substance arising from human activities and released into the environment is petroleum hydrocarbons (crude oil). Crude oil is a vital non-renewable natural resource that has emerged as a prominent commodity in the local and international market with numerous benefits for producing nations like Nigeria where it is an important part of the Nigerian economy since 1958 (Oyedeji et al., 2015). Demand and utilization of petroleum products have increased its exploration in Nigeria and globally. Oil spills is one serious environmental problem associated with petroleum exploration with consequent environmental contamination, degradation and negative impacts on ecosystems. Typical constituents of petroleum hydrocarbons are heavy metals that are poisonous even at low concentrations. Heavy metal contamination is one major issue faced throughout the world, requiring attention because heavy metals above their normal ranges are extremely threatened to both plant and animal life (Nazir et al., 2015). Over the years, chemical dispersants and physical or manual scooping are methods adopted to decontaminate the environment after oil pollution. According to Frick et al., (1999), these processes are expensive and still have some adverse effects on the environment. However, in recent times, efforts have focused on biological techniques such as bioremediation and phyto-remediation in ameliorating conditions created by crude oil spills (Gupta and Sinha, 2007; Njoku et al., 2009). These techniques are environmentally-friendly and is already being practiced in many countries like United States of America, Britain and Brazil with significant positive results (Oyedeji et al., 2015). These techniques are non-destructive and cost effective in-situ technology that uses plants and associated microbes to clean up contaminated soils.(Nie et al., 2011). Plant based bioremediation

technology have received increased attention in the recovery of polluted environment but studies on the use of animal based organic substance such as RBW in bioremediation is scanty. RBW has high pH and is a large store house of microbial organism, enzymes and elements some of which may be necessary for plant growth and development (Isirima, Akonye & Iyagba 2017). Each time ruminant animals are slaughtered in the abattoir the product of the rumen are heaped and carelessly abandoned with little or no regard for its possible used in augmentation and remediation of crude oil polluted crop lands. It is on this premise that this study aims at determining the effectiveness of rumen-based waste in reducing heavy metal accumulation in leaf and tuber of the test crop (cassava).

Materials and Methods

The experiment was conducted at the Teaching and Research Farm of the Federal College of Education (Technical) Omoku. The land for the experiment was fallowed for four years after cassava grown on it was harvested. The loamy soil was ploughed and plant thrash removed. The experiment was laid in a split plot fitted into completely randomized design with 3 replications. Crude oil pollution levels (0litre m^{-2} , 1.5litre m^{-2}, 3litre m^{-2} and 4.5litre m^{-2} constituted the main plot while, rumen-based waste(0, 2, 4 and 6kg/m^{-2}) formed the subplot. Each sub-plot measuring 2m x 2m was made into raised bed of 30cm high. Bonny light crude oil was obtained from OB/OB plant of Nigeria Agip Oil Company (NAOC), measured and applied at the rates of 0ml, 1500ml 3000ml and 4500ml with the aid of a watering can. Watering can was preferred to ensure uniform distribution of the crude oil. Care was taken to avoid splash effect. Rumen-based waste freshly obtained from an abattoir in Omoku was applied at the rates of 0, 2, 4 and 6kg/m^2 two weeks after crude oil treatment. Cassava stems (TMS/80/001935) were then planted on the soil earlier polluted with the crude oil and augmented with rumen-based waste. Stems were planted at 1m x 1m spacing two weeks after crude oil and rumen-based waste treatment. Atomic Absorption Spectrometer (AAS) was used to analyze cassava leaf and tuber samples for heavy metals (nickel, lead and copper). The instrument setting and operational conditions were set according to manufacturer's specifications.

Results and Discussion

Table 1 shows that nickel accumulation increased with increasing rumen based waste augmentation at all crude oil levels except at the severe level where it decreased with increasing rumen based waste augmentation. Lead accumulation also decreased with increasing rumen-based waste augmentation at 3MAP and 6MAP at all spill simulation levels. Mean copper concentration at the double control treatment (0ml crude oil and 0kg rumen based waste) was 5.75mg/kg. This value is lower than mean copper levels obtained at various crude oil simulation levels with 0kg rumen based waste. Mean values decreased at 6MAP as quantity of rumen-based waste increased from 2kg, 4kg to 6kg, at various simulation levels showing the potency of rumen-based waste in reducing copper accumulation in cassava leaf.

Table 1: Heavy Metals (Nickel, Lead and Copper) concentrations in cassava leaf

Treatments		Metal concentration in cassava leaf(mg/kg)					
Crude oil levels	Rumen Based Waste	Nickel (Ni) 3MAP	Nickel (Ni) 6MAP	Lead (Pb) 3MAP	Lead (Pb) 6MAP	Copper (Cu) 3MAP	Copper (Cu) 6MAP
	0 kg/m^2	8.95	8.49	6.40	9.76	4.63	6.86
Control	2 kg/m^2	11.28	8.50	7.20	9.50	5.23	5.20
(0ml/m^2)	4 kg/m^2	11.30	10.35	7.20	9.32	8.71	4.17
	6 kg/m^2	11.28	10.60	7.40	9.32	8.50	4.12
	0 kg/m^2	8.35	8.50	6.0	8.0	7.20	5.60
Mild	2 kg/m^2	8.65	9.0	4.210	7.80	7.10	5.20
(1500ml/m^2)	4 kg/m^2	9.15	10.35	3.00	7.62	6.75	5.01
	6 kg/m^2	9.20	10.42	3.00	7.21	6.80	5.00
	0 kg/m^2	9.00	9.21	5.00	6.30	7.00	5.80
Moderate	2 kg/m^2	9.25	10.12	4.00	6.20	7.40	5.70
(3000ml/m^2)	4 kg/m^2	9.35	10.80	3.80	6.19	7.83	5.56
	6 kg/m^2	9.50	14.86	3.70	6.00	8.20	5.50
	0 kg/m^2	8.12	6.32	5.60	5.14	7.83	7.10
Severe	2 kg/m^2	7.00	4.21	5.20	4.98	8.70	6.20
(4500ml/m^2)	4 kg/m^2	6.31	2.39	5.20	4.71	9.00	4.72
	6 kg/m^2	6.30	2.50	5.00	4.00	9.15	4.22

Heavy metals adversely affect soil ecology, quality of agricultural produce and human health (Nazir et al., 2015). In the current study, nickel, lead and copper accumulation levels in cassava leaf and tuber were ascertained. The observed high nickel concentration in cassava leaf with application of highest (6kg/m^2) rumen-based waste treatment level suggest that degradation of rumen-based waste promoted availability and uptake of nickel in the cassava tissue under control experiment. Decrease in lead and copper concentration in the leaf with increasing levels of rumen-based waste augmentation shows the potency of the organic manure to reduce accumulation of the lead and copper in cassava leaf.

Table 2 shows that nickel was not detected in cassava tuber at the double control and across various levels of RBW treatment of the control experiment, but crude oil + RBW augmentation enhanced accumulation of nickel in the cassava tuber. Greater Nickel accumulation was recorded at higher rumen-based waste augmentation. Lead value of the cassava tuber under double control (No crude oil + No rumen-based waste) was 1.00mg/kg, whereas highest rumen-based waste (6kg) augmentation recorded a lead value range of between 1.40 and 1.80 across mild, moderate and severe crude oil treatment. Copper status of the cassava tuber was 1.02mg/kg at the double control experiment but increased with increasing augmentation to 2.81mg/kg at severe crude oil level. Again copper value obtained across mild, moderate and severe crude oil treatment was higher than mean copper value of 1.02mg/kg obtained at the double control treatment. In this case, rumen-based waste enhanced copper accumulation in cassava tuber.

Table 2: Heavy Metals (Nickel, Lead and Copper) concentrations in cassava tuber

Treatments		**Concentrations in cassava tuber at 6MAP (mg/kg)**		
Crude oil levels	**Rumen Based Waste**	**Nickel (Ni)**	**Lead (Pb)**	**Copper (Cu)**
Control (0ml/m^2)	0 kg/m^2	Not Detected	Not Detected	1.02
	2 kg/m^2	Not Detected	1.00	1.62
	4 kg/m^2	Not Detected	1.40	2.70
	6 kg/m^2	Not Detected	1.40	2.73
Mild (1500ml/m^2)	0 kg/m^2	2.50	1.00	2.50
	2 kg/m^2	2.58	1.00	2.53
	4 kg/m^2	2.70	1.00	2.54
	6 kg/m^2	2.75	1.40	2.55
Moderate (3000ml/m^2)	0 kg/m^2	2.78	1.10	2.40
	2 kg/m^2	2.80	1.40	2.50
	4 kg/m^2	3.00	1.40	2.65
	6 kg/m^2	3.17	1.41	2.67
Severe (4500ml/m^2)	0 kg/m^2	3.02	1.20	2.60
	2 kg/m^2	3.00	1.50	2.60
	4 kg/m^2	3.14	1.80	2.71
	6 kg/m^2	3.17	1.80	2.81

Nickel has been considered to be an essential trace element for human and animal health (Zigham *et al.,* 2012). Absence of nickel in cassava tuber across levels of rumen-based waste in the control experiment and the observed increase in the level of nickel in the crude oil + rumen-based waste augmentation implies that activities of hydrocarbon and degradation process of RBW enhanced deposition of the heavy metal in cassava tubers. Nickel level was within WHO permissible limits of 10mg/kg (Zigham *et al.,* 2012; Nazir *et al.,* 2015). Lead as a soil contaminant is a widespread issue; It accumulates with age in bones aorta, and kidney, liver and spleen. Lead levels increased from not detected (ND) to 1.80mg/kg at the highest levels of severity and rumen-based augmentation. However, lead levels were within WHO permissible limit of 2mg/kg (Zigham *et al.,* 2012; Nazir *et al.,* 2015). Lead is especially accumulated in surface soil horizon because of its low water solubility and mobility especially within an environmentally relevant pH range. Lead is a non essential element and its presence in very toxic levels could lead to neurological problems, it could endanger health and cause enzymatic changes, anaemia and hyperactivity (Barkirdere and Yaman, 2008). Copper, though an essential trace element, may be toxic to both humans and animals when concentration exceeds safe limits. Copper levels increased from 1.02mg/kg at double control to 2.81mg/kg at highest levels of severity and rumen-based augmentation. Copper levels above permissible limits could lead to blood shortage, abdominal pains, nausea, diarrhoea, headache, dizziness and liver cirrhosis (Iqbal *et al.,* 2011;

Chinedu *et al.,* 2011). Copper levels were within WHO permissible limits of 10mg/kg (Zigham *et al.,* 2012; Nazir *et al.,* 2015). Findings of this study agrees with Akonye and Onwudiwe (2007) who observed high accumulation of heavy metal (lead) lead at 2% pollution with saw dust augmentation

Conclusion

Cassava tubers showed increased heavy metals (Nickel, Lead and Copper) content as rumen based waste augmentation increased. While rumen based waste reduced accumulation of heavy metals in leaf of cassava at specific crude oil levels, it enhanced the accumulation of these metals in cassava tuber that is mainly utilized in cassava crop production. Rumen-Based Waste is therefore not a very good material for remediation of crude oil polluted soils as it enhances the accumulation of heavy metals that are dangerous to human health.

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Effect of Seed Size on Growth and Yield Development of Fluted Pumpkin (*Telfairia occidentalis* Hook f)

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Abstract
Fluted pumpkin popularly known as Ugwu is a tropical rain forest crop. Production in the drier zone of the Nigeria has been faced with constraint such seed size, seed placement, fertilizer application among others as such making it costly. Field and pot experiment were therefore conducted at the teaching and research farm of Faculty of Agriculture, Bayero University Kano. The aim of the experiments is to determine the effect of seed size on the vegetative growth and yield of fluted pumpkin (Telfairia occidentalis Hook F). The treatments were seed size, Large, Medium and Small which were laid out in a randomized complete block design (RCBD) for the field experiment and completely randomized design (CRD) for the pot experiment. These were replicated four (4) times. The results obtained shows that seed size had a significant effect on days to emergence, vine length, number of leaves, number of branches, number of male and female flowers and total fresh shoot yield. Large and medium size fluted pumpkin seed produced longer length of vine, higher number of leaves, more branches, flowered earlier and produce higher marketable fresh shoot yield than small seed. It is therefore recommended that large and medium size Telfairia occidentalis seed should be used for the production of fluted pumpkin in the Savanna region of Nigeria.

Introduction
Vegetables constitute essential components of human nutrition because they are very rich in vitamins, protein, minerals, oil among others (Akoroda, 1990). *Telfairia occidentalis* (Fluted pumpkin) is a perennial, dioecious herb. The crop is one of the most important vegetables grown in southern Nigeria. It is generally regarded as a leaf and seed vegetable. Common names of the crop include fluted guard, fluted pumpkin, iroko and Ugwu, mainly cultivated by Igbo people (Akanbi *et al.,* 2007). The leaf of *Telfairia occidentalis* has a high nutritional, medicinal and industrial uses being rich in protein (29%), fat (18%) and minerals and vitamins (20%). In the recent time, *Telfairia occidentalis* has gained medicinal recognition. It has been discovered to be blood purifier (Aletor *et al*., 2002) and could therefore be useful in maintenance of good health more especially among poor resource people in developing countries. The rind and pulp of *Telfairia occidentalis* as reported by (Akanbi *et al.*, 2007), can be used as fodder for livestock. Pregnant women and patients suffering from anaemia use the leaf juice to strengthen their blood.Despite the importance of *Telfairia* in Nigerian diet, farmers are facing a lot of problems concerning its production in the field, more especially here in the Northern regions. These problems include inadequate researches which will recommend appropriate size of seed to be used during planting. Research efforts are therefore, required to formulate the recommended seed size on the growth yield and development fluted pumpkin. There is therefore, need to look into the agronomic practices, since there is no much work done on the crop in this region and thus, the objective of this paper is to determine the effect of seed size on the vegetative growth of *Telfairia occidentalis*.

Materials and Methods
Matured pods of *Telfairia occidentalis* obtained from the National Horticultural Research Institute, Bagauda were split to obtain the seed. A total of 360 seeds were used for both field and pot experiment. For the pot experiment, one seed per pot was directly planted at the depth of 0.5 cm on 36 prepared pots of soil mixture consisting of river sand, top soil and organic manure at

the ratio of 2:1:1 while for field experiment nine (9) seeds were planted per plot at a spacing of 1m between plants, giving a total of 324 seeds. The experimental treatments applied during the planting were placing Large, Medium and Small seeds. The seed size was obtained by weighing the seeds and categorized into small, medium and large 9.19, 14.51 and 18.95g respectively. NPK (15:15:15) fertilizer at the rate of 200kg/ha i.e. 80g per plot was applied at three weeks after planting (WAP) for the field experiment while 0.2g/ha was applied per pot for the potted experiment. Field management was done by hoe weeding at 2, 4 and 6 WAP and pots management was done by picking at subsequent time. Watering at 2-3 times per week and spraying of Superplus® 280EC (a combination of cypermethrin and Dimethoate) to control pest at the rate of 1.5L/ha at 7 WAP. Long Bamboo stakes of 2m were used to make trellis for the plants to climb at 4 WAP. At 5 WAP tips of the plants were decapitated to avoid apical dominance that may allow the plants to spread on the trellis.Three plants were randomly sampled from each plot in the case of field experiments for better precision and the mean was calculated for each parameter under investigation. While in the case of pot experiment observation was carried out on every pot. Data were collected on Number of Days to Emergence (DTE), Vine length, Number of Leaves and Number of Branches (NOB) per plant at 6, 9 and 12 WAP. Number of flowers (Male and Female) was recorded at 9 and 12 WAP on field plant (Table 6) and Fresh Shoot Weight (FSW) was collected at 12, 14 and 16 WAP (Table7). The data collected were analysed using the procedure described by Cochran and Cox (1967), general linear model of SAS (SAS, 1989) and significant differences among the treatment means were evaluated using Duncan's multiple Range test (DMRT) as described by (Duncan, 1955).

Results and Discussion

Seed size was observed to affect plant germination in both field and pot experiments. The results showed that large and medium seeds germinated earlier than smaller seeds. This could probably be due to the fact that large seeds had enough food reserve which always allow the seed plumule to penetrate through deep layer of the soil.Similar observation was reported by Brady,(1990) that small seed do not germinate earlier because of the little reserved nutrients, as such they do not have the ability to penetrate through a deep layer of soil because of the insufficient stored materials to generate the osmotic gradient necessary to overcome the pressure exerted by the soil. Lang and Holmes, (1964) also found germination and early growth to be enhanced by size of the seeds.The length of vine, number of leaves and number of branches was significantly affected by seed size in both experiments.Large seeds produced significantly longer vine, more number of leaves and branches than medium sized seed (Table 2,3 and 4) respectively. This is in line with the work of Akoroda, (1990) on Telfairia that large seed gave higher number of leaves, branches and vine length which may be due to seed vigour or the size of the seed. Similar observation was reported by Barry *et al.*, (2001) on potatoes crop that seed size has significant effect on growth and yield of the plant. Number of Male and Female flowers was found to be significantly affected by seed size. Large and medium seed flower earlier and the ratio of male to female flower is higher. This could be due to the fact that large and medium seeds germinated earlier and attained higher number of leaves, branches and longer vine length as such flower earlier when compared with small seed. Similar results were reported by Brown, (1994) that large or heavier seed of tomatoes produced plants that flowered earlier and gave better yield than small or lighter seed. Fresh shoot weight was significantly affected by size of the seed (Table 7). It was observed that large and medium seed gave better yield than small seed. This could be due to the fact that large and medium seed had earlier germination as such gave higher yield. This is in line with the work of Alam and Locascio,(1965), Akoroda,(1990), Tafi *et al.,* (2003) and Ojeifo and Ajekenrenbeaghan, (2006) that plant height, fresh shoot weight and yield increased with the seed size of vegetable crops.Flowering as one of the reproductive characters of development is not set in the pot experiment. This is due to the fact that the root of potted plants are restricted from the soil nutrient (Table 6).

Conclusion

Result of this study revealed that the seed size of Telfairia seeds had a significant effect on days to emergence, length of vine, number of leaves, number of branches, number of Male and Female flowers and Total fresh shoot yield. Based on the finding of this study, peasant farmers are therefore advice to use large and medium size fluted pumpkin seed (*Telfairia occidentalis)* for better marketable fresh shoot yield.

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Table 1: Effect of Seed Size on Days to Emergence and Days to Flowering of *Telfairia occidentalis* at Bayero University Kano in 2009 rainy season

Treatment	Field	Pot
Seed Size		
Small	11.70b	13.20b
Medium	19.70ba	14.40
Large	21.40a	16.52
SE+_	0.431	5.115

Means followed by the same letter are not significantly different at 5% level of significant using (DMRT)
(DMRT) = Duncan multiple range test
SS= Seed Size
WAP= Weeks after planting

Table 2: Effect of Seed Size on Number of Branches of *Telfairia occidentalis* at 6, 9, and 12 Weeks After Planting at Bayero University Kano in 2009 Rainy season.

Treatment	**6WAP**		**9WAP**		**12WAP**	
	Field	Pot	Field	Pot	Field	Pot
Seed Size						
Small	1.44b	0.21b	2.32b	0.30b	2.84c	0.59
Medium	2.01a	0.34a	3.16a	0.40b	3.40b	0.81
Large	2.21a	0.53a	3.31a	0.70a	4.30a	1.00
SE+_	0.166	0.184	0.155	0.153	0.158	0.185

Means followed by the same letter are not significantly different at 5% level of significant using (DMRT)
(DMRT) = Duncan multiple range test
SS= Seed Size
WAP= Weeks after planting

Table 3: Effect of Seed Size on Vine Length (cm) of *Telfairia occidentalis* at 6, 9, and 12 Weeks After Planting at Bayero University Kano in 2009 Rainy season.

Treatment	6WAP		9WAP		12WAP	
	Field	Pot	Field	Pot	Field	Pot
Seed Size						
Small	53.02c	29.14b	80.62c	34.73b	109.33c	32.76b
Medium	69.11b	42.11a	102.44b	48.61a	142.32b	47.90a
Large	73.54a	41.57a	110.7a	48.63a	160.12a	51.21a
SE+_	2.088	1.037	2.684	2.790	3.464	3.724

Means followed by the same letter are not significantly different at 5% level of significant using (DMRT)
(DMRT) = Duncan multiple range test
SS= Seed Size
WAP= Weeks after planting

Table 4: Effect of Seed Size on Number of Leaves of *Telfairia occidentalis* at 6, 9, and 12 Weeks After Planting At Bayero University Kano in 2009 Rainy season

Treatment	6WAP		9WAP		12WAP	
	Field	Pot	Field	Pot	Field	Pot
Seed Size						
Small	15.04b	11.82b	41.84b	13.00	59.82b	16.00b
Medium	21.41a	14.80a	65.62a	17.04	101.86b	22.04ab
Large	21.42a	15.84a	72.04a	17.42	110.00a	24.12a
SE+_	1.091					

Means followed by the same letter are not significantly different at 5% level of significant using (DMRT)
(DMRT) = Duncan multiple range test
SS= Seed Size
WAP= Weeks after planting

Table 6: Effect of Seed on Number of Male and Female Flowers of *Telfairia occidentalis* At Bayero University Kano at 2009 Rainy season

Treatment	Female flower	Male flower
	Field	Field
Seed Size		
Small	0.54b	1.30b
Medium	5.10a	10.00a
Large	6.63a	8.79a
SE+_	1.545	1.735

Means followed by the same letter are not significantly different at 5% level of significant using (DMRT)
(DMRT) = Duncan multiple range test
SS= Seed Size
WAP= Weeks after planting

Table 7: Effect of Seed Size on Cumulative Fresh Shoot Weight (g) Per Plot and Per Plant and Total Yield in kg/ha of *Telfairia occidentalis* at Bayero University Kano in 2009 rainy season

Treatment	Shoot wt/plant(g)		Shoot wt/plot/plant(g)		Fresh shoot yield(kg/ha)	
	Field	Pot	Field	Pot	Field	Pot
Seed Size						
Small	200.68b	14.1b	595.65c	42.00b	2588.80b	1029.90c
Medium	338.73a	23.04ab	1016.04b	71.32a	3880.00a	1348.50b
Large	351.70a	25.33a	1333.14a	75.91a	4097.70a	1689.80a
SE+_	21.779	1.818	13.614	5.923	399.909	265.192

Means followed by the same letter are not significantly different at 5% level of significant using (DMRT)
(DMRT) = Duncan multiple range test
SS= Seed Size
WAP= Weeks after planting

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Effect of Municipal Solid Waste and NPK Fertilizer on Yield of Maize and Groundnut Intercrop in Asaba, Delta State, Nigeria

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Abstract
Field experiment on effect of municipal solid waste and NPK fertilizer on yield and yield parameters of maize and groundnut intercrop in Asaba was carried out in the Demonstration farm of Federal College of Education (Technical), Asaba during. The objective was to compare the effect of combine and sole application of Municipal Solid Waste (MSW) and NPK fertilizer rate on yield and harvest index of Maize and groundnut intercrop A 6 X 3 factorial experiment in randomized complete block design (RCBD) was used. The two factors studied were nutrients and cropping system. The six nutrients applied were 0 control 100%MSW, 100%NPK, 50%MSW +50%NPK, 75%MSW+ 25%NPK, 25%MSW+ 75%NPK,while cropping systems used were sole maize, sole groundnut and maize/groundnut intercrop. MSWC at 100% and combination of 75% MSW+ 25% NPK recorded the highest yield of 1967kg and 1833kg for maize and 4900kg and 4700kg for groundnut respectively. The use of sole cropping system gave greater yield than intercropping system.

Key words: Municipal Solid Waste, NPK, Maize Yield, Groundnut Yield and Harvest Index

Introduction
Soil is a natural body upon the earth on which crops grow, and its quality varies widely, ranging from very old, weathered and leached rocks to soils inherently law in nutrient because of their clay and organic matter content (DFID 2002) According to UNU-INRAL World Bank report, (1999), nutrient level have declined over the past 30years, resulting to low levels of minerals like nitrogen (N), phosphorus(P) and potassium (K). It is patent to note that bulk of our crop productivity can be traced to a large extent to soil infertility. However many research have identified the usefulness of compost and farmyard manure in the maintenance of organic matter status, amelioration of physical chemical and biological properties of the soil (Stevenson, 1992, swift and Sanchez, 1994). Municipalities are facing a growing problem of how to dispose their solid waste. Municipal solid waste is primarily organic waste, such as leaves, skins and unsold food, discarded at or near food markets (United Nations Environmental Programme (UNEP 2009). Bryan and Morton (2007), sees municipal solid waste (MSW) as waste from multifamily, commercial and industrial e.g. Schools. In most developing countries like Nigeria waste from markets and other public places are used as landfills or dumped where people no longer use. Organic compost account for about 75% of total MSW in Nigeria (Oyinlola, 2001). In order to minimize environmental impacts and loss of organic resources composting is a measure that must be employed to convert MSW into organic manure for plant growth. Composting is one of the major recycling processes by which nutrients present in organic materials are returned by to the soil in plant available from (Incket *et al* ; 1996). The low fertility status of most tropical soils hinders crop production as most crops have exhausting effect on the soil.(Onwudiwe 2014).Inorganic fertilizers such as NPK , exerts strong influence on plant growth, development and yield (Stafano,Dris and Rapparini 2004). However excessive or continual application of NPK fertilizer will lead to loss of soil fertility due to improper use and this has adverse effect on crop productivity. Groundnut can be planted sole or intercropped. However, it performs better as sole crop (Dania, Fagbola and Alabi, 2014). Limitation in groundnut production ranges from land availability, labour, fund, availability of appropriate fertilizers dosage, disease control, post harvest challenges, proper storage to marketing. Groundnut is an excellent source of organic nitrogen and nutrient recycling. It increases organic nitrogen and nutrient recycling. It increases

organic matter and improves soil structure and quality and can be intercropped with maize, sorghum, cassava, and melons (Tabo, Ezuch, Ajayi, Asiegbu, Singh, 1995). Therefore maize (Zea mays .L) is an important cereal crop grown in most tropical African countries for human consumption, livestock and for industrial purposes. Alabi and Esobhawan (2006) states that maize is often planted in intercropping system in many tropical countries like Nigeria. Dania, Fagbola and Alabi, (2014) proved that intercropping maize with groundnut is an insurance against crop failure, erosion control, and efficient use of land, stability of yield, risk minimization, continuous and diversified food supply and higher yield.

Materials and Methods

Field experiment was carried out in the Demonstration farm of Federal College of Education (Technical) Asaba . Asaba is located at latitude 06^2 25^1 N and longitude 06^0 49^1 E of the equator. This location lies in the tropical rainforest zone and it is characterized by rainfall periods of between April and October with bimodal rainfall distribution (NIMET, 2016). Municipal solid wastes used for the study were collected from waste bins in markets and within the college hostels. Biodegradable materials were sorted out and decomposed aerobically. The compost materials used for the study were free from dour and dark in colour. The chemical fertilizer used for the study was NPK (15:15:15). The experimental design used was 6 X 3 factorial in randomized complete block design (RCBD). The two factors studied were nutrients and cropping system the six nutrients applied were 0 control, 100% MSW, 100% NPK, 75% MSW+ 25% NPK, 25% MSW+ 75% NPK, 50% MSW+ 50% NPK. MSWC and NPK were combined to produce 18 treated combinations which were replicated three times. The treatments were applied two weeks after planting (WAP) in ring from (10 to 15cm from the plant) and mixed properly with the soil at the plants base. Harvest index was obtained by calculating from the formula:

$$\frac{\text{Seed weight (g/plant)}}{\text{Total dry matter of plant material (g/plant)}}$$

Data was subjected to analysis of variance (ANOVA); means were separated using fishers least significance (F-LSD) Procedure as described by Obi (2002). Test of significance was at 5% probability level.

Results and Discussion

The result presented in Table 1 showed that treatment of MSW and NPK fertilizer and cropping system had significant ($p<0.05$) effects on the yield of maize. Sole cropping system significantly (p<0.050 effect on maize yield when compared to intercrop while 100% MSWC had the highest yield 1967kg/ha, 17.77g and 1867kg/ha, 17.7kg. Nutrient x cropping system had significant effect on yield at all levels of interaction. Groundnut yield was significantly ($p<0.05$) influenced by MSW, NPK and cropping system, while 100% MSW gave significantly ($p<0.05$) highest plant yield (4900kg/ha) when compared with other treatment combination sole cropping system gave highest yield (3233kg/ha) than intercropping system (3189kg/ha), while nutrient x cropping system had no significant effect on grain yield of intercrops.

Conclusion

The use of sole cropping system had greater yield. However, intercropping of maize and groundnut increased the productivity per unit of land of the experimental sight. Intercropping of maize and groundnut helped in effective utilization of nutrients, weed control and erosion control. This is in line with the findings of Thayamini *Saran and Brinth* (2010) and Shrikishnah,Umaraijini and Seran (2008). It is recommended that farmers should combine 75%MSW and 25%NPK rather than sole application of NPK fertilizer for better yield; also, intercropping maize and groundnut should be encouraged for effective utilization of available land resources.

Table 1: Effect of Municipal Solid Waste (MSW) and NPK Fertilizer on Maize Yield at first and second planting

	FIRST PLANTING						SECOND PLANTING					
Nutrient	Yield kg/ha			100 Seeds Weight (g)			Yield kg/ha			100 Seeds Weight (g)		
	Sole	Intercrop	Mean	Sole	Intercrop	Mean	Sole	Intercrop	Mean	Sole	Intercrop	Mean
0 control	1333	1233	1283[c]	10.3	8.4	9.35[c]	1133	800	966[c]	7.4	6.2	6.8[c]
100% MSW	1967	1867	1917[a]	17.8	15.7	16.8[a]	1700	1600	1650[a]	15.0	13.7	14.4[a]
100% NPK	1500	1067	1283[c]	11.0	7.7	9.4[c]	1300	1033	1166[b]	9.0	7.6	8.7[b]
50% MSW + 50% NPK	1767	1667	1717[a]	16.0	14.0	15.0[a]	1600	1600	1600[a]	13.6	13.7	13.7[a]
75% MSW + 25% NPK	1833	1300	1566[b]	16.4	12.0	14.2[a]	1433	1600	1516[a]	12.4	13.7	13.1[a]
25% MSW + 75% NPK	1667	1667	1667[a]	13.6	11.7	12.6[b]	1433	1333	1383[a]	11.4	10.0	10.7[b]
Mean	1678[a]	1467[b]		14.18[a]	11.68[b]		1433[a]	1327[a]		11.44[a]	10.81[a]	
CS LSD (0.05)		161.3			1.57			234.1			1.81	
N LSD (0.05)		279.4			2.73			406.0			3.14	
N x CS (0.05)		395.1*			574.2*			3.86*			4.44	

N – Nutrients, CS – Cropping System, N- Significant at 5% level of probability. Means with the same letter are not significantly different at 5% level of probability

Table 2: Effects of Municipal Solid Waste (MSW) and NPK Fertilizer on Groundnut Yield during first and second planting

Nutrient	FIRST PLANTING						SECOND PLANTING					
	Yield (kg/ha)			100seeds (g)			Yield (kg/ha)			100seeds (g)		
	Sole	Intercrop	Mean	Sole	Intercrop	Mean	Sole	Intercrop	Mean	Sole	Intercrop	Mean
0 control	1767	1800	1783e	14.0	14.3	14.15d	1150	1060	1100e	9.5	8.0	8.8d
100% MSW	4900	4233	4566 a	30.0	28.0	29.0 a	2967	2700	2833 a	20.9	17.0	19.0 a
100% NPK	1967	2467	2217d	17.7	17.5	17.6c	1700	1800	1750	10.0	12.0	11c
50% MSW + 50% NPK	3100	3400	3250b	27.0	25.0	26.0b	2800	2400	2600b	20.0	14.0	17.a 0
75% MSW + 25% NPK	4700	4033	2566c	29.0	27.0	28.0 a	2500	2633	2566c	15.0	16.3	15.7b
25% MSW + 75% NPK	2967	3200	3083b	19.7	20.0	19.9c	1600	1933	1766d	12.0	13.3	12.7c
Mean	3233 a	3189 a		22.89 a	21.98 a		2011 a	2088 a		14.58 a	13.44 a	
CS LSD (0.05)	131.5			1.3 3			136.0			1.36		
N LSD (0.05)	227.8			2.27			235.6			2.36		
NXCS	322.1*			3.28^{NS}			333.2*			2.33^{NS}		

N – Nutrients, CS – Cropping System, N- significant at 5% level of probability. Means with the same letter are not significantly different at 5% level of probability

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Response of Okra *[Abelmoschus esculentus*(l.) Moench] to Rates of NPK 20:10:10 and Neem- Based Organic Fertilizers in Calabar, Nigeria

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Abstract
A pot experiment was carried out in 2016 at the screen house of the University of Calabar Teaching and Research Farm, Calabar, Cross River State, Nigeria to evaluate the effects of rates of NPK and neem based organic fertilizer on soil properties and the performance of okra. Seven (7) treatments including the control (no amendment) and two nutrient sources (neem based organic fertilizer and NPK 20:10:10) each applied at 3 levels of nitrogen (80,100,120 kg N/ha) were fitted into a completely randomized design (CRD) and replicated three times. Data were subjected to analysis of variance and means compared with Duncan New Multiple Range Test at 5 % level of probability. The soil used for the study was extremely acid (4.38), loamy sand in texture and low in fertility. The results of the trial revealed that application of NPK and Neem based organic fertilizer significantly (P<0.05) improved the soil properties with the organic sources recording higher values. The use of fertilizer either organic or inorganic source improved the number of leaves, leaf area, stem girth, plant height and number of fruits of okra. The improvement increased as the rate of application increased but neem-based organic fertilizer treated soils produced higher fruit weight of okra than the NPK treated soils. The highest okra fruit weight of 6400 kg/ha was obtained in pots treated with 120 kg N/ha Neem and is therefore recommended for sustainable production of okra in Calabar and other regions with similar climatic conditions.
Keywords: Neem based organic fertilizer, NPK 20:10:10, soil properties, okra performance and Ultisol

Introduction
Okra (*Abelmoschusesculentus (L) Moench*), is an important vegetable crop that is widely cultivated and consumed in Nigeria and other tropical countries of the world. It is the only vegetable crop of significance in the malvaceae family and is grown both in tropical and sub-tropical regions of the world (Ahmed *et al.*, 2006).It has been observed that farmers are facing a lot of problems on its sustained productivity as soil tends to be highly weathered and have low inherent fertility. The applications of inorganic and organic fertilizers are the usual approach of soil fertility maintenance. Organic and inorganic fertilizers have their merits and demerits for instance; organic fertilizers are slow release nutrient sources. This implies that crops can suffer initial starvation from nutrient immobilization prior to mineralization. They are also required in large quantities which may not be readily available to small scale farmers (Iren *et al*., 2016).In an organic fertilizer use, production of crops free from heavy metal contamination will be guaranteed (Asadu and Unagwu 2012). On the other hand inorganic fertilizer ensures quick availability of nutrients to crops but they have limited residual effect of the applied nutrient (Iren *et al*., 2015).Reckless use of these nutrient sources without knowing the appropriate rate to apply can create nutrient imbalance that limits the uptake of other essential nutrients and cause soil acidity leading to low crop yields. Neem-based organic fertilizer is a natural organic fertilizer produced from neem-seed kernel (OrgoNeem, 2015). It is a non-synthetic soil amendment that enhanced soil quality, thereby improving the vegetative and seed parts of crops (Subbalakshmi *et al*., 2012).Therefore; this study was designed to assess the effects of rates of NPK and neem-based organic fertilizers on soil properties and the performance of okra in Calabar.

Materials and Method

Description of the study location: The experiment was conducted at the screen house of the Teaching and Research Farm of the University of Calabar, Calabar in Cross River State. The area lies between latitude 5° 32' and 4° 27' N and longitude 7° 15' and 9° 28' E. The total rainfall ranges from 2000- 3500 mm annually while the mean temperature ranges from 23 -33 °C. The mean relative humidity is 60- 90 %.

Collection and preparation of material/ Experimental design and treatments: Plastic buckets (7Litrecapacity) were perforated at the bottom to allow for easy drainage and facilitate aeration. Surface soil samples (0-15 cm) collected randomly from the Teaching and Research Farm of the university were thoroughly mixed, air dried and passed through a 4 mm size sieve and 6 kg of the soil was measured into each of the plastic buckets.Seven (7) treatments including the control (no amendment) and two nutrient sources (neem based organic fertilizer and NPK 20:10:10) each applied at 3 levels of nitrogen (80,100,120 kg N/ha) were fitted into a completely randomized design (CRD) and replicated three times. The neem – based organic fertilizer treatments were applied to specified pots based on the calculated N rate and thoroughly mixed with the soil, watered to field capacity and kept for a period of five days before sowing the okra seed while the NPK fertilizer was applied to specified pots three weeks after sowing.

Planting and crop management / Data collection: Four (4) okra seeds were planted in each pot and were later thinned down to two plants per pot two weeks after planting (WAP). The pots were watered at regular intervals to maintain soil moisture at field capacity. The growth parameters measured after one month of planting were number of leaves per plant, leaf area, stem girth and plant height and these continued at two weeks interval. Number of fruits and fruit weights were taken per harvest and the average recorded at the end of the experiment.

Soil sampling/Laboratory analyses: One composite soil sample was taken before experiment and at the end of the experiment; soil in each pot was sampled for analysis. The soil samples were air dried, ground and sieved with 2 mm size sieve and physicochemical properties analyzed following standard procedures as outlined by Udo *et al*. (2009). The properties analyzed include particle size distribution, pH (H_2O), organic carbon, total nitrogen, available phosphorus, exchangeable bases and exchangeable acidity. Effective cation exchange capacity and base saturation were calculated.

The neem-based organic fertilizer was also subjected to chemical analysis.

Data analysis: Data collected were subjected to analysis of variance (ANOVA) using statistical package of Social Science software programme (SPSS) version 18 (2009) and the means were compared using Duncan New Multiple Range Test (DMRT) at 5% probability level.

Results and Discusion

Physico-chemical properties of the soil before the study: The physico-chemical properties of the soil before the study and nutrient composition of the neem-based organic fertilizer are presented in Table 1. The soil texture was loamy sand with 84.3 % sand, 8.7 % silt, and 7.0 % clay. The soil was extremely acid with a pH value of 4.38 as rated by Adaikwu and Ali (2013). The soil organic carbon, total nitrogen, exchangeable bases, exchangeable acidity and ECEC were low; the available phosphorus content of the soil was high while base saturation was moderate. The low fertility status of the soil necessitates the need for application of soil amendments.

Influence of NPK and neem based organic fertilizer on soil chemical properties: The chemical properties of the soil after experiment are shown in Table2. The results showed that the treatments applied significantly ($P< 0.05$) improved the soil pH relative to the control. The highest pH value was obtained from soil treated with 120 kg N/ha Neem (4.98) followed by100 kg N/ha Neem (4.91). The least pH value of 4.40 was obtained in control plot and was not lower than the value of 4.44 obtained from plot treated with 120 kg N/ha NPK.The organic carbon, total nitrogen, total exchangeable bases, ECEC and base saturation levels of the soil were significantly ($P < 0.05$) improved by the treatments applied with the highest values mostly obtained in soils treated with 120 kg N/ha Neem. The available phosphorus contents of all the amended soils weresignificantly reduced relative to the control. These reductions might be attributed to the uptake of phosphorus by the okra plant. The exchange acidity level was also significantly ($P< 0.05$) reduced in the amended soil while the base saturation level was significantly ($P < 0.05$) increased.

Table 1: Physicochemical properties of soil before experiment and characteristics of the crude oil used

Soil property		Nutrient content of the neem-based organic fertilizer	
Parameter	Value	Parameter	Value
Sand (%)	84.3	pH (H_2O)	7.8
Silt (%)	8.7	pH (KCl)	6.4
Clay (%)	7.0	Organic carbon (%)	12.4
Textural class	loamy sand	Organic matter (%)	21.58
pH (H_2O)	4.38	Total N (%)	3.00
Organic carbon (%)	0.80	C: N ratio	4.14
Total nitrogen (%)	0.07	Total P (mg/kg)	1.82
Available P (mg/kg)	40.30	Total K (mg/kg)	2.75
Exch. Ca (cmol/kg)	2.45	Total Ca(mg/kg)	1.46
Exch. Mg (cmol/kg)	0.82	Total Mg (mg/kg)	0.91
Exch. Na (cmol/kg)	0.06	Zn (ppm)	360
Exch. K (cmol/kg)	0.09	Cu (ppm)	138
TEB (cmol/kg)	3.42	Fe (ppm)	420
Exch. acidity (cmol/kg)	4.85	Mn (ppm)	96
ECEC (cmol/kg)	8.27	NH_4^-(mg/kg)	65.7
Base saturation (%)	41.35		

Influence of NPK and neem based organic Fertilizer on growth parameters of okra

Table 3 shows that there were significant ($P < 0.05$) influences of NPK and neem- based organic fertilizer on growth parameters of okra plant. Number of leaves per okra plant was significant across all the growth stages measured with the amended soils producing more leaves relative to the control except at 4WAP where only the 120 kg N/ha Neem treated plot was significantly higher than the control.The highest number of leaves per okra plant was obtained from the plot amended with 120 kg N/ha Neem in all the growth stages measured (Table 3). This agrees with the findings of Olatunji and Oboh (2012) and Iren *et al*. (2016) who reported increases in the number of okra leaves with the application of organic based fertilizer.The leaf area of okra was significant ($P < 0.05$) across all the growth stages withthe broadest leaf obtained from plants treated with 120 kg N/ha Neem. At 12 WAP, the broadest leaf of 53.87 cm^2 obtained by plants treated with the highest rate of neem –based organic fertilizer was not wider than those obtained by other rates but was more than the NPK treated plants. There were significant ($P < 0.05$) increases in stem girth of okra plants across all the growth stages with the soils treated with neem-based organic fertilizer producing biggest stem than NPK fertilizer and the stem girth increases as the rate of application increases. There was significant increase in plant height of okra at different growth stages (Table 3). At 4 WAP, only the plants treated with 120 kg N/ha Neem was significantly taller than the control but at other stages of growth, plants treated with 120 and 100 kg N/ha Neem were taller than the plants in the control pots. Generally, the untreated plants were shorter than the treated plants at all the growth stages. This agrees with the findings of Odiete *et al*. (1999) and Iren *et al*. (2016) who reported increase in okra plant height by the application of amendments. The influence of NPK and neem-based organic fertilizers on number of fruits and fruit weight of okra was significant (Table 4) with the highest number of fruits (19.00) and fruit weight (6400 kg/ha) of okra obtained from the application of 120 kg N/ha Neem which was significantly more than other treatments. All the other treatments did not differ significantly from one another but were more than the control.

Conclusion

The use of fertilizer either organic or inorganic source improved the soil nutrient availability, growth and yield of okra. The improvement increased as the rate of application increased but neem-based organic fertilizer treated soils produced higher fruit weight of okra than the NPK treated soils. The highest okra fruit weight of 6400 kg/ha was obtained in pots treated with 120 kg N/ha Neem and is therefore recommended for sustainable production of okra in Calabar and other regions with similar climatic conditions.

Table 2: Influence of NPK and neem based organic fertilizers on soil chemical properties

Treatments (kg/ha)	pH (H_2O)	Org. C (%)	Total N (%)	Av. P (mg/kg)	Exchangeable bases (cmol/kg)				Exchangeable acidity (cmol/kg)		TEB	ECEC	BS (%)
					Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	Al^{3+}	H^{+}			
Control	4.40e	0.83d	0.65d	39.90a	2.68f	0.86e	0.20e	0.09b	1.48a	2.92a	3.83d	8.23b	46.54d
120 kg N/ha NPK	4.44de	0.87cd	0.78c	38.28b	2.82e	0.91cd	0.23de	0.10b	1.45a	2.52b	4.06c	8.03c	50.56c
100 kg N/ha NPK	4.48cd	0.87cd	0.78c	35.81de	2.87de	0.92cd	0.27c	0.13b	1.42b	2.65b	4.19c	8.26b	50.72c
80 kg N/ha NPK	4.50c	0.86cd	0.78c	37.48bc	2.88cd	0.91cd	0.25cd	0.10b	1.41b	2.45b	4.14c	8.00c	51.75b
120 kg N/ha Neem	4.98a	1.05a	0.98a	34.23ef	2.99a	1.04a	0.53a	0.23a	1.31d	2.44b	4.79a	8.54a	56.09a
100 kg N/ha Neem	4.91b	0.95bc	0.92ab	36.28cd	2.95ab	0.95bc	0.29bc	0.17a	1.40bc	2.62b	4.36b	8.38ab	52.03bc
80 kg N/ha Neem	4.54c	0.94bc	0.88b	33.60f	2.93bc	0.98b	0.33b	0.17a	1.38c	2.51b	4.41b	8.30b	53.13b

Means within a column not sharing a letter in common differ from each other significantly at 5% level of probability following Duncan new multiple range test (DNMRT)

Table 3: Influence of NPK and Neem based organic fertilizer on growth parameters of okra plant

Treatment (kg/ha)	Mean Number of Leaves					Mean leaf area of okra (cm^2)				
	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
Control	3.13b	3.26c	3.33c	3.34c	3.34c	9.03c	15.03b	20.30c	20.30c	21.00b
120 kg N/ha NPK	3.67b	5.33b	5.67b	5.73ab	5.77ab	17.50b	33.10a	29.67bc	29.77bc	29.80b
100 kg N/ha NPK	3.67b	5.33b	5.37b	5.67ab	5.67ab	8.53c	14.13b	20.47c	25.13bc	26.00b
80 kg N/ha NPK	3.67b	5.00b	5.37b	5.67ab	5.67ab	9.20c	15.23b	25.57c	26.00bc	26.73b
120 kg N/ha Neem	5.33a	7.33a	7.48a	7.63a	7.76a	39.13a	35.37a	41.07a	48.17a	53.87a
100 kg N/ha Neem	4.00ab	6.00ab	6.67ab	6.67ab	6.77ab	20.20b	33.13a	33.23b	35.57b	47.40a
80 kg N/ha Neem	4.00ab	5.00b	6.33ab	6.33ab	6.53ab	10.60c	30.97a	35.27b	43.00ab	47.70a
Treatment (kg/ha)	**Mean stem girth of okra (cm)**					**Mean plant height (cm)**				
Control	1.90c	2.10c	2.20b	2.40c	2.40b	7.33b	7.77c	7.80c	8.00c	8.00c
120 kg N/ha NPK	3.20b	3.30bc	3.50b	3.60bc	3.60ab	9.33b	11.77abc	12.50b	12.77abc	13.00c
100 kg N/ha NPK	3.00bc	3.10bc	3.30b	3.60bc	3.63ab	9.83b	11.27abc	13.07b	13.07abc	13.63bc
80 kg N/ha NPK	3.00bc	3.10bc	3.40b	3.50bc	3.57ab	10.27b	11.87abc	13.07b	13.83abc	13.87bc
120 kg N/ha Neem	4.33a	5.30a	6.10a	6.17a	6.40a	14.10a	15.23a	18.33a	22.43a	27.23a
100 kg N/ha Neem	3.83ab	4.23ab	4.87ab	4.90abc	5.10ab	10.33b	12.53ab	13.83b	14.50ab	15.33b
80 kg N/ha Neem	3.40ab	3.80ab	4.33ab	4.36abc	4.67ab	10.10b	11.43abc	12.10b	12.70abc	12.70bc

Means within a column not sharing a letter in common differ from each other significantly at 5% level of probability following Duncan new multiple range test (DNMRT).

Table 4: Influence of NPK and Neem-based organic fertilizer on number of fruits and fruit weight of okra plant

Treatment (kg/ha)	Mean Number of fruits per plant	Fruit weight (kg/ha)
Control	9.0c	1800c
120 kg N/ha NPK	13.34b	5300b
100 kg N/ha NPK	12.74b	5100b
80 kg N/ha NPK	12.66b	4800b
120 kg N/ha Neem	19.00a	6400a
100 kg N/ha Neem	16.42b	5300b
80 kg N/ha Neem	16.33b	5000b

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Effect of Soil Available Phosphorus on Shoot Yield of Cowpea (*Vigna unguiculata* (L.) Walp.) and Dry Matter

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Abstract
Phosphorus is a major nutrient required for cowpea growth, nodulation, root development, maturity and tolerance to field pests and diseases. Cowpea's yield in farmers field are below average of the genetic potential partly due to poor soil fertility of dry savannah areas, where the crop is majorly cultivated. It provides food over 200 million people, feed for livestock and cash for all the value chain actors. The use of phosphorus-based (P) fertilizer to provide cowpea with needed amount of P to complement the low-P from soil comes with financial and environmental cost, as P fertilizers are relatively expensive, not readily-available and excessive use of P could result in pollution of water bodies. In addition, global reserves of rock phosphate, a crucial ingredient for producing phosphorus fertilizers are limited and fast depleting. Therefore, breeding cowpea that acquire and use P from sub-optimal soils would reduce these costs. The variation in shoot yield and its correlation with root dry matter was quantified among 30 cowpea genotypes with varying performance. Genotypes were grown at zero, low and high P soils in a ratio 1:1 of low-P field soil to river-sand in three replications under screen house conditions using Hoagland nutrient solution. Results have showed existence of genotypes with above average performance under varying P levels as estimated via biomass production, and was associated with root development, as root biomass increased with increasing P content. This work provides information demonstrating potential of developing varieties with improved P acquisition and use efficiency in cowpea.

Introduction
Cowpea (*Vigna unguiculata* [L.] Walp) is an important legume crop which provides food and feed for human and livestock. The grains are rich in essential amino acids, thereby making it an important supplement to cereal-based meals for most families (Boukar *et al.*, 2018; Ojiewo *et al.*, 2018). Realized yield of the crop among farmers is low partly due to poor soil fertility especially low nitrogen and phosphorus in soils of most growing areas in West and Central Africa that accounts for substantial share of global production (Abate *et al.*, 2012). Phosphorus (P) is an essential nutrient for cowpea (Armstrong and Griffin, 1991; Adusei, 2015; Hussain, 2017), and the concertation of available P in the soil is often time low leading to slow diffusion of P to the root surface (Miguel, Postma and Lynch, 2015). P is one of the most limiting nutrient for cowpea and use of inorganic P fertilizer is advocated for achieving high yield and stability (Hammond *et al.*, 2009). Application of P fertilizers for higher gains appears to be unsustainable due to the financial and environmental costs associated with heavy fertilization. In the low inputs systems, these fertilizers are beyond reach of most local farmers while in the high input systems of the developed nations, intensive P usage could lead to excess soluble P ending up in the water bodies and polluting the aquifers that may result in loss of biodiversity. Developing cowpea varieties with ability to efficiently acquire and use P is an important strategy to reduce the use and reliance on synthetic P fertilizers, such that crop plants would produce above average yield with minimal use of inorganic P and higher returns when is sufficiently applied. This study used shoot biomass under low and high P conditions as a measure of P acquisition and use efficiency respectively. There is considerable within crop species genetic variation in the measure of P use

and acquisition (Hammond *et al.*, 2009). However, they observed that differences in the response of yield to P fertilization do not appear to correlate with P uptake efficiency (PUtE). Thus, selection for greater PUtE does not appear to be an effective strategy for developing crops that yield well on soils with low P availability. However, genotypes of crop plants that yield well and have lower tissue P concentrations can be used to reduce P-fertilizer inputs. There is a body of literature that pointed to variation in cowpea to various measures of P use efficiency (Kolawole, Tian and Singh, 2000; Sanginga, Lyasse and Singh, 2000; Mahamane, 2008; Olaleye *et al.*, 2011) and root hairs (Krasilnikoff, Gahoonia and Nielsen, 2003). The main object of this work was to investigate variation in shoot yield of cowpea to varying P levels and strength of association with root dry matter, this will provide critical information required for selecting cowpea for improved root system development.

Materials and Methods

Plant material

Thirty cowpea genotypes of which 20 are parents of recombinant inbred lines previously described (Muchero *et al.*, 2009; Huynh *et al.*, 2013, 2018; Muñoz-Amatriaín *et al.*, 2017) and 10 popular Nigerian lines were used to quantify the varying levels of P nutrient for shoot yield.

Screening experiment

A subsoil (20-40 cm) was collected from Institute for Agricultural Research-Ahmadu Bello University low-P research field and analyzed for physiochemical properties. The collected subsoil was mixed with acid washed river sand in the ratio of 1:1 and 5kg of the final mixture was weighed into pots (24 x 24 cm) for planting. A modified Hoagland nutrient solution used by (Johnson, Vance and Allan, 1996) on lupin and (Rothe, 2014) on some cowpea lines with little modifications on P concentration was adopted. Stock solutions were prepared for each of the nutrient salts ad defined quantities of stock solution were then measured out (see experimental procedure) into a 20 litre bucket, and reverse osmosis (RO) was used to make up the required volume for watering various P treatments, the pH was adjusted to 6.5 with NaOH or HCl. P was supplied as $Ca(H_2PO_4)_2.H_20$ at 0 mg, 1.5 mg and 30 mg for the zero, low and high P treatments, which were equivalent to 0 M, 25.0 μM and 0.5 mM of $Ca(H_2PO_4)_2.H_2O$ in the nutrient solution.

Experimental procedure

The thirty (30) cowpea lines were planted in a total of 270 pots as a factorial arrangement under three (3) P levels; 0 mg, 1.5 mg and 30 mg P/kg, with genotypes and P levels as treatments arranged in a randomized complete block design with three replications. All pots received 3.0 mM KNO_3, 2.5 mM $Ca(NO_3)_2$, 1.0 mM $MgSO_4$, 12.0 μM FeEDTA, 4.0 μM $MnCl_2$, 22.0 μM H_3BO_3, 0.4 μM $ZnSO_4$, 0.05 μM $NaMoO_4$, 1.6 μM $CuSO_4$ except and $Ca(H_2PO_4)_2.H_2O$ that was applied to only low and high P pots (Johnson et al., 1996; Rothe, 2014). Prior to planting, seeds were treated with a commercial fungicide (AllStar) according to manufacturer's recommendation and pots were watered to field capacity with 1000 ml of RO water. Two seeds were planted per pot, and were later thinned to one per pot at ten days after sowing (10 DAS). Pots were watered with nutrient solution described earlier as follows; 300 ml of dilute nutrient solution per pot at planting, and subsequently 300 ml was applied at 3 DAS, 6 DAS, 9 DAS, 16 DAS, 23 DAS, 30 DAS, 37 DAS, 44 DAS, and 51 DAS, these quantities of nutrient solution were dispensed using graduated beakers. Pots were periodically watered with RO water to prevent wilting and accumulation of salts in the soil. Plants were protected against insect pests by spraying Karate (50 g/l lambda- cyhalothrin, Syngenta Crop Protection AG, Basle, Switzerland) at a rate of 1.0L ha-1 as at when insects were found on plants.

Data collection and analysis

At eight weeks after sowing (WAS), plant height was measured, and all the genotypes were uprooted; the shoots were detached from the roots at above soil surface using secateurs. Roots were cleaned by repeated washing under a running tap to remove soils under a 1mm mesh opening. Fresh shoot and root samples were dried for 24 hours in the screenhouse under ambient temperature, and later moved to an incubator (Percival, Boone IOWA 50036) set at 60-65^{o}C for 36 hours and weighed using a digital scale (Scout^{tm} pro SPU202, Ohaus Corporation). In addition to plant height, shoot dry biomass (g), root dry biomass (g) were measured while total biomass, shoot to root and root to shoot ratios were computed. Prior to weighing, dried roots were checked for any soil particles, which were removed if found. Data were analyzed for differences in the parameters recorded and means were generated from SAS proc GLM (SAS 9.4, licensed to West Africa Centre for Crop Improvement) while graphical representation of the results were made using principal component analysis with built-in R functions *prcomp* on the pooled means of ANOVA (Kassambara, 2017).

Results and Discussion

Principal component analysis (PCA) was performed to reduce the dimensionality of the data by removing its redundancy, identify hidden patterns and correlated variables. The results showed that the first component which was mainly influenced by shoot, root and total plant biomass explained 49.9% of total variance (Figure 1), while the second component with main contributions from root to shoot and shoot to root ratios accounted for 22.6% of total variability. The graph of correction circle (Figure 2) revealed positively correlated variables pointing to the same direction, namely; shoot, root and total plant biomass, and these were negatively correlated with root to shoot ratio that was projected in the opposite side of the map. Variables that were far away from the origin of the PCA plane implies good representation on the map while those close to the origin are least represented on the components plane and may be better explained by other components. Measuring dry biomass has proven as the most potent criteria (Armstrong and Griffin, 1991; Hammond *et al.*, 2009; Korkmaz and Altıntaş, 2016) for estimating P response and use, this is because P deficiency slows down utilization of carbohydrate by plants and it is easily manifested as amount of biomass produced under sub-optimal conditions. Loss in yield is another obvious symptom associated with P deficiency for most field grown plants. Similarly, P deficiency results in delayed maturity, reduced fruit size and quality, and decreased tolerance to diseases (Armstrong and Griffin, 1991; Armstrong, 1999). Results from the present study supported reports of earlier works that P contained in the growth medium is critical for optimum yield in cowpea (Kolawole, Tian and Singh, 2000; Sanginga, Lyasse and Singh, 2000) and shoot yield is correlated with root dry matter production (Li *et al.*, 2009), as root system responds to P availability in the soil.

Conclusion

The differential performance of cowpea under varying soil P levels was successfully demonstrated. Shoot biomass production among same genotypes treated with different P concentration has showed role of P nutrition in supporting normal growth and development. Effect of P nutrient was more apparent on the shoot system than the root system leading low shoot to root ratio. Root dry weight was equally reduced in treatments with no to low P, and dry weight was associated with shoot dry weight. These findings will provide important information for selecting desired parents to initiate breeding programmes to develop cowpea varieties with improved P use and acquisition efficiency.

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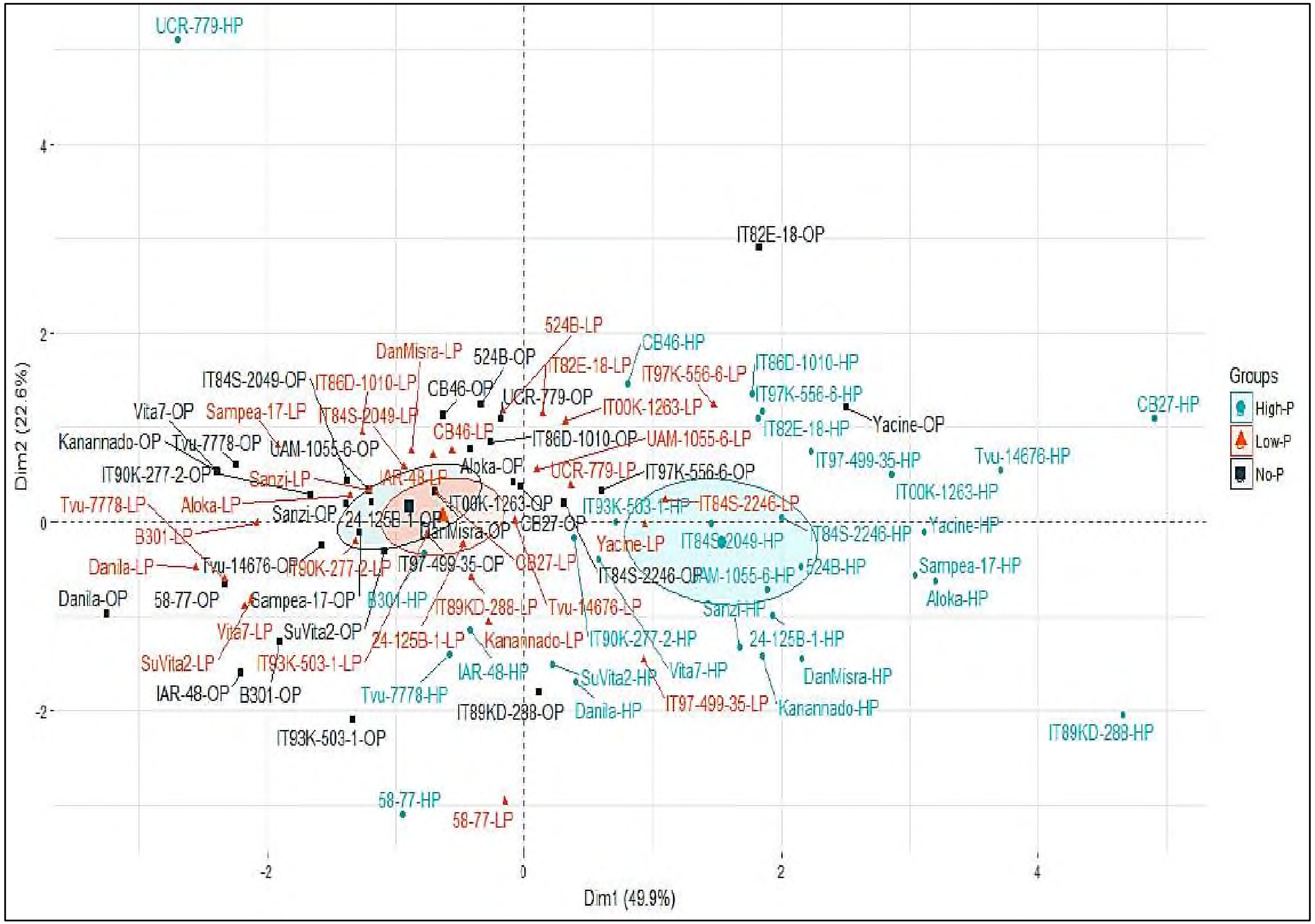

Figure 1: Projection of cowpea genotypes on principal components plane. *Genotypes in Green = high phosphorus, Orange = low phosphorus and black = no external phosphorus treatments

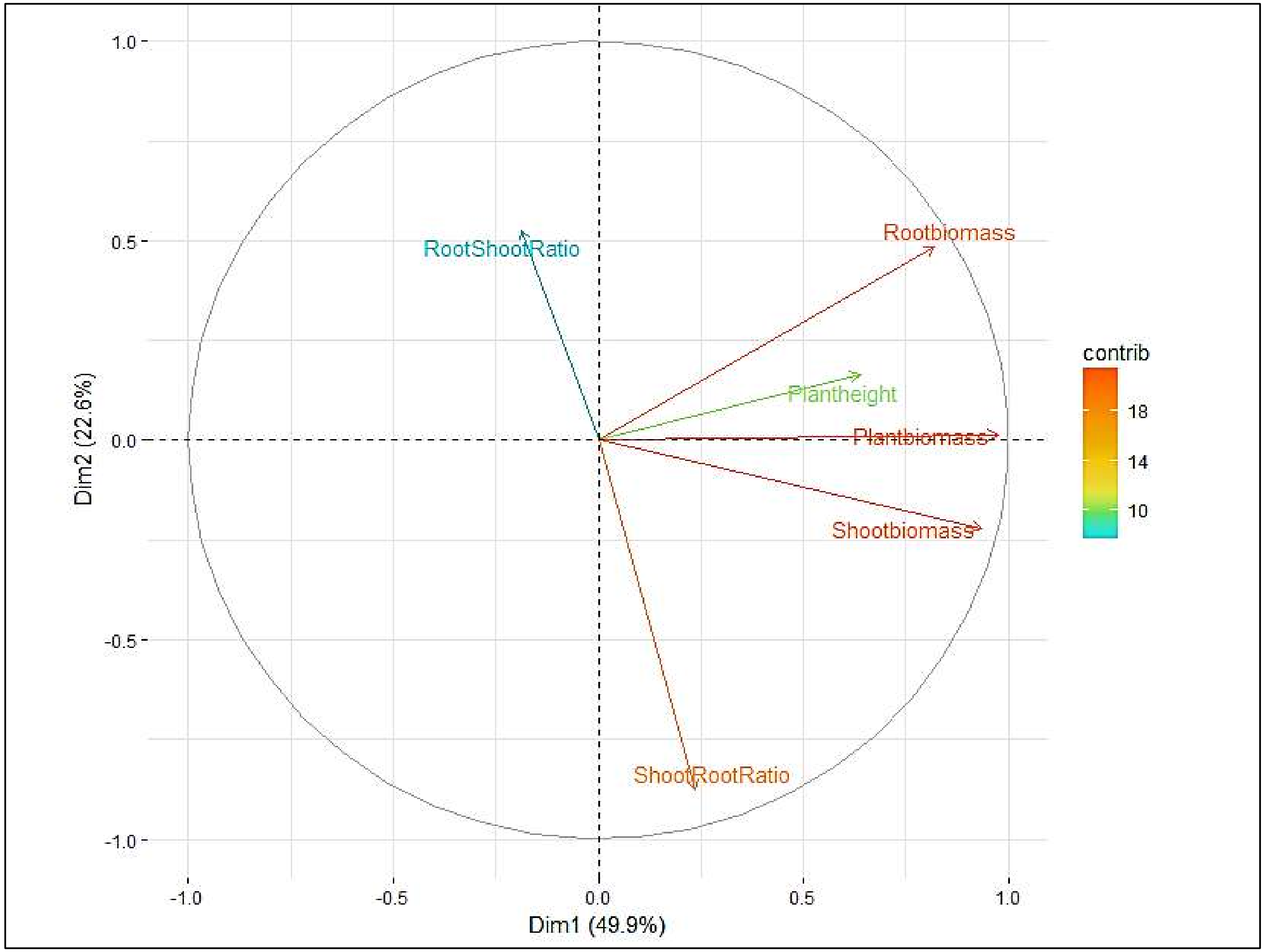

Figure 2: Correlation circle showing relationship of various variables of cowpea genotypes under varying P treatments

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Insecticidal Effects of Some Aqueous Plant Extracts against *Callosobruchus maculatus* (Fab.) (Coleoptera: Chrysomelidae) on Stored Cowpea Seeds

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Abstract
Laboratory experiments were conducted to determine the effects of aqueous extracts of Terminalia mantaly H. Perrier (Combretaceae), Fragaria vesca (L) (Rosaceae), Ficus thonningii Blume (Moraceae) and Ribes nigrum (L) (Grossulariaceae) at 2.0, 4.0 and 6.0 ml/100g of raw extracts against Callosobruchus maculatus on stored cowpea seeds. Untreated control was also set up. Efficacy of the aqueous extract was assessed based on adult mortality at 1, 3 and 5 days after treatment (DAT) and progeny production. The experiment was conducted under ambient laboratory conditions at temperature of 32.2 ± 3°C and 33.9 ± 5% relative humidity. The results revealed that adult mortality increased with an increased concentration and exposure intervals. The percentage adult mortality ranged from 10.0 to 76.7% and was highest at 6.0 ml of Black Currant aqueous extracts; which was significantly different ($p < 0.05$) from untreated control at 1 day after treatments (DAT). Similar trends were observed at 3 and 5 DAT. On the other hand, all the treatment significantly ($p < 0.05$) reduced F_1 and F_2 progeny production compared to the untreated control. The results suggest that these plant materials tested have the insecticidal potential. Hence, it should be incorporated into post-harvest protection against, C. maculatus, the major insect pest of stored cowpea seeds.

Keywords: Callosobruchus maculatus, Cowpea seeds, Aqueous extracts, Adult mortality and Progeny production

Introduction
Cowpea (*Vigna unguiculata*) is a food and animal feed crop grown in the semi-arid tropics covering Africa, Asia, Europe, United States and Central and South America (IITA, 2016). The grains contain 25% protein, and several vitamins and minerals. More than 5.4 million tons of dried cowpeas are produced worldwide, with Africa producing nearly 5.2 million (IITA, 2016). Nigeria, the largest producer and consumer, accounts for 61% of production in Africa and 58% worldwide (IITA, 2016). One of the major constraints to cowpea storage is attack by an insect pest. *Callosobruchus maculatus* Fab. (Coleoptera: Chrysomelidae), is the most important insect pest of cowpeas (Ileke *et al*., 2013; Ahmed *et al*., 2014). It is a cosmopolitan pest that causes considerable economic damage. (Profit, 1997; FAO, 2004). Adults may be found outdoors in flowers in early spring and colonize the cowpea field at the end of the rainy season carrying the bruchid populations into the stores where they continue to develop (van Huis, 1996; FAO, 2004). Eggs laid by females hatch in 5 to 20 days. Larvae typically feed inside the cowpea, taking from 2 weeks to 6 months to develop before pupating. Six or seven generations may occur per year. Larvae chew near the surface and leave a thin covering uneaten which appears as a "window". Later the adult emerges from the ""window" (FAO, 2004). They prefer dried cowpeas but will attack other beans and peas in storage. Adults move about readily and can infest seeds in the field, but can also breed continuously in stored dry cowpeas. Larvae typically develop inside the dried peas (FAO, 2004). Damages caused by these storage pests include weight loss, loss in quality and market value. This causes quantitative and qualitative losses, reduced seed germination and nutritional value (Jackai, and Daoust, 1986; FAO, 2004). The damage cause by *C. maculatus* and other storage insect pests can be effectively control by the use of synthetic

insecticides like Rambo powders, Pestox powders, Malathion powders and Actellic dust. However, several problems are associated with their usage such as health hazard, increasing costs of the insecticides, development of resistance by the insect pests, scarcity and environmental hazard (EPA, 2001). In view of that, efforts are being focused on the use of plant materials that are relatively cheap, readily biodegradable, less toxic to other beneficial organism (Niber *et al*., 1994; Mukanga *et al*., 2010; Adedire *et al*., 2011; Ahmed *et al*., 2014; Chudasama *et al.,*2015; Longe, 2016). Therefore, the present study was conducted to evaluate insecticidal potentials of *Terminalia mantaly* H. Perrier (Combretaceae), *Fragaria vesca* (L) (Rosaceae), *Ficus thonningii* Blume (Moraceae) and *Ribes nigrum* (L) (Grossulariaceae) aqueous leaves extracts against *C. maculatus* on stored cowpea seeds.

Materials and Methods

Study site

The experiment was conducted in the Entomology Laboratory, Department of Crop Protection, University of Maiduguri. Maiduguri is located in the Sahel Savanna region of North-Eastern Nigeria at latitude 11°05' North and longitude 13°05' East (Daura, 2002). The temperature and relative humidity in the laboratory were recorded with Omson's hygrometer.

Rearing of *C. maculatus*

The adult *C. maculatus* used to establish the insect culture was obtained from infested stocks cowpea seeds purchased from Maiduguri Monday Market, Borno State - Nigeria and kept in Entomology Laboratory, Department of Crop Protection, University of Maiduguri. C*. maculatus* was subsequently reared on cowpea seeds (cv. Borno brown) in 1- Litre glass jars. The jars were covered with perforated lids to permit ventilation and prevent escape of adult insects. The culture was maintained under ambient laboratory conditions (temperature of 32.2 ± 3°C and 33.9 ± 5% relative humidity).

Source of cowpea seeds

Two kilograms of cowpea *Vigna unguiculata* (cv. Borno brown) used for the study was purchased from the Maiduguri Monday Market, Borno State - Nigeria. It is the most preferred variety, brown in colour. The seeds were fumigated with aluminum phosphide (Phostoxin® tablet) in an air tight container for 7 days. The seeds were later air dried in the laboratory bench for three days to allow for dissipation of the fumigant.

Collection of plant material

Fresh leaves of *T. mantaly* (Madagascar almond), *F. vesca* (Wood strawberry), *Ficus thonningii* (Common wild fig) and *R. nigrum* (Black currant) were collected from Ornamental Plant Garden Opposite Total Filling Station, Bama road, Maiduguri and authentication of the plant was done by a Botanist. The leaves of these plant materials were subjected to washing to remove all dust particles then dried to remove moisture. It was then milled into powders using pestle and mortar. The powders were further sieved using 1mm^2 metallic sieve to obtain fine powder. The powders were preserved in air tight glass jars until needed.

Preparation of Plant extracts

Twenty grams each of dried leaf powder was soaked in 100 ml of distilled water for 24 hours. Extract was filtered through a double layered muslin cloth followed by Whatman No. 1 filter paper and used for the experiment immediately.

Bioassay Procedures

One hundred grams of cowpea seeds were weighed into 500 ml glass jars using Mettler weighing balance and admixed with 2.0, 4.0 and 6.0 ml/100g of each aqueous extract and an untreated control was also included. After treatment, all the jars, except the untreated control, were vigorously shaken to ensure an effective admixture and the contents were allowed to settle for an hour. Thereafter, each jar was infested with twenty 1-2 days adult *C. maculatus* of mixed sexes. Each jar was then covered with a lid, which was cut at the middle but sealed with a mesh to facilitate ventilation and prevent escape of the insects. Each treatment was replicated three times. The jars were labeled and arranged in a completely randomized design on the laboratory table under ambient conditions for 90 days. Mortality assessment was conducted 1, 3 and 5 days after treatment (DAT), by emptying the contents of each jar on a plastic tray, where dead and live insects were counted and recorded. The dead insects were removed while the live ones were returned into their respective jars. Insects were considered dead if appendages did not move when touch with a blunt object. Thereafter, the jars were left undisturbed for the emergence of the F_1 (30 - 40 days after treatments), F_2 generation (70- 80 days after treatments). The number of adults that emerged from each jar was counted and recorded.

Statistical analysis
Mortality data were corrected for control mortality using the Abbott's (Abbott, 1925) formula. Prior to the statistical analysis, an arcsine transformation of the adult mortality data as well as a square root transformation of the progeny production data was performed to standardize the data. The data was subjected to one-way ANOVA using Minitab Statistical software (version 17) and Tukey - Kramer (HSD) tests at $p < 0.05$ was used for the post hoc separation (Zar, 1999).

Results and Discussion

The effects of some aqueous extract on the mortality of adult *Callosobruchus maculatus* are presented in Table 1. Results indicated that the highest adult mortality percent (76.7%) occurred at the highest concentration (6 ml) of Black Currant aqueous extracts, while the lowest mortality percent (10.0%) occurred at the lowest concentrations (2 ml) of Woodland Strawberry aqueous extracts, Madagascar Almond aqueous extracts and, Common Wild Fig aqueous extracts, compared to (6.7%) for the untreated control at 1 DAT. Similarly, complete adult mortality (100%) was caused at the highest concentration (6 ml) of Black Currant aqueous extracts, meanwhile the lowest value (10.0%) occurred at the lowest concentration (2 ml) of Madagascar Almond aqueous extracts and Common Wild Fig aqueous extracts, compared to (6.7%) for the untreated control at 3 DAT. Similar trend of mortality was observed at 5 DAT. In the present investigation the insecticidal activity of aqueous leaves extract of *T. mantaly*, *F. vesca*, *F. thonningii* and *R. nigrum* have been evaluated for the control of *C. maculatus* on stored cowpea seeds. The results indicated that the extracts of the four plant species exhibited high level (10-100%) of insecticidal activity against *C. maculatus* and proved significantly different from the untreated control. The insecticidal activity of these plant materials could be attributed to the phytochemical constituents of various the plant materials. These results confirmed the previous work conducted by (FAO, 2004; Adedire *et al*., 2011; Ahmed *et al*., 2014; Longe, 2016) which reported that plant materials can be used effectively as grain protectants against cowpea bruchids and other storage insect pests. The effect of some aqueous extracts on *Callosobruchus maculatus* adults emergence are presented in Table 2. The results indicated that the Black Currant aqueous extracts at (6 ml) recorded the lowest number of F_1 adults progeny (2.0), which was significantly different ($p < 0.05$) from the untreated control (303.0). On the other hand, the number of F_2 adult emergence recorded from the aqueous extracts ranged between 12.0 to 213.7 which was significantly different ($p < 0.05$) from the untreated control (470.0). Aqueous leaf extracts of *T. mantaly*, *F. vesca*, *F. thonningii* and *R. nigrum* clearly suppressed the emergence of *C. maculatus* adult populations on stored cowpea seeds. The reproduction potential was greatly reduced but not completely inhibited and this could be attributed to the toxic effect of these extracts as well as to oviposition deterrent effects, delayed egg-hatching and growth disrupting effects of these extract. Several studies (Niber *et al*., 1994; Mukanga *et al*., 2010; Adedire *et al*., 2011; Ahmed *et al*., 2014; Chudasama *et al.,*2015; Longe, 2016) have also reported the ability of some leaf extracts to inhibit the reproductive capacity of stored product insect pests including *C. maculatus*. The effects of these extracts may also blocked the insect spiracles leading to asphyxiation and death. This finding are in agreement with Adedire *et al*. (2011) who reported that plant materials prevented insects from breathing through blockage of their spiracles.

Conclusion

From the study, it is concluded that application of *T. mantaly*, *F. vesca*, *F. thonningii* and *R. nigrum* aqueous leaf extracts on stored cowpea seeds may control the damage caused by the cowpea bruchids *C. maculatus* and more studies are needed to isolate and extract the active compounds in these plant materials.

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Table 1: Effect of some aqueous plant extracts on the mortality of adults *Callosobruchus maculatus*

Treatments	**Concentration (ml/100 g)**	**Mean adult mortality (±SE) days after treatment**		
		1 day	3 days	5 days
BCAE	2.0	13.3±0.2^{e}	13.3±1.3^{d}	16.67±1.3^{e}
	4.0	30.0±0.1^{bc}	36.7±1.3^{bc}	40.0±0.1^{bcd}
	6.0	76.7±1.2^{a}	100.0±0.0^{a}	100.0±0.0^{a}
WSAE	2.0	10.0±0.1^{d}	13.3±0.2^{d}	13.3±0.2^{f}
	4.0	23.3±1.2^{bc}	26.7±0.8^{bc}	30.0±1.3^{de}
	6.0	63.3±0.8^{ab}	73.3±1.6^{ab}	80.0±1.5^{abc}
MGAE	2.0	10.0±0.1^{d}	10.0±0.6^{e}	16.67±1.1^{e}
	4.0	20.0±1.5^{bc}	26.7±1.6^{bc}	26.7±0.7^{de}
	6.0	60.0±1.8^{ab}	70.0±1.0^{ab}	83.3±0.9^{ab}
CFAE	2.0	10.0±0.1^{d}	10.0±1.2^{e}	13.3±0.2^{f}
	4.0	23.3±1.3^{bc}	33.3±1.2^{bc}	36.7±0.8^{cde}
	6.0	73.3±1.7^{a}	93.3±0.3^{a}	96.7±1.2^{a}
Untreated control	0.0	6.7±2.3^{f}	6.7±0.6^{f}	10.0±0.3^{g}

Means followed by the same letter(s) within a column are not significantly different from each other (Tukey – Kramer's (HSD) at $p < 0.05$%.

BCAE - Black Currant aqueous extracts, WSAE -Woodland Strawberry aqueous extracts, MGAE -Madagascar Almond aqueous extracts, CFAE- Common Wild Fig aqueous extracts.

Table 2: Effect of some aqueous plant extracts on *Callosobruchus maculatus* progeny production

Treatments	Concentration (ml/100 g)	Mean number adult emergence (±SE)	
		F_1 adult	F_2 adult
BCAE	2.0	22.3±0.6^{bc}	173.7±3.8^{bc}
	4.0	3.3±0.4^{c}	13.3±1.6^{e}
	6.0	2.0±0.6^{c}	12.0±1.5^{de}
WSAE	2.0	13.3±1.3^{c}	107.7±1.2^{bcde}
	4.0	13.0±1.2^{c}	75.7±0.5^{bcde}
	6.0	5.7±1.0^{c}	54.0±3.4^{bcde}
MGAE	2.0	93.0±1.3^{b}	213.7±3.3^{ab}
	4.0	48.7±0.7^{bc}	44.7±1.5^{cde}
	6.0	4.7±0.3^{c}	125.3±2.1^{bcd}
CFAE	2.0	13.3±1.4^{c}	176.0±3.1^{bc}
	4.0	12.7±1.9^{c}	70.0±1.7^{bcde}
	6.0	5.3±1.3^{c}	40.3±1.4^{cde}
Untreated control	0.0	303.0±1.9^{a}	470.0±3.8^{a}

Means followed by the same letter(s) within a column are not significantly different from each other (Tukey – Kramer's (HSD) at $p < 0.05$%.

BCAE - Black Currant aqueous extracts, WSAE -Woodland Strawberry aqueous extracts, MGAE -Madagascar Almond aqueous extracts, CFAE- Common Wild Fig aqueous extracts.

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Effect of Poultry droppings and NPK on the growth and yield of Carrot- *Daucus carota* L

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Abstract
A field experiment on the effects of poultry droppings and NPK15:15:15 on the growth and yield of carrot was carried out at the Faculty of Agriculture demonstration farm, University of Port Harcourt. The experiment was laid out in a completely randomized design of four treatments (Poultry dropping, NPK15:15:15, combination of Poultry droppings + NPK15:15:15, and control) with three replications. The result showed that the application of the treatments had significant influences (P=0.05) on all parameter studied (number of leaves, plant height, diameter of root, length of root, fresh weight of root, dry weight of roots, fresh weight of leaves, dry weight of leaves, gross yield, and marketable yield). The result revealed that the application of the Poultry droppings was found to be suitable for maximum gross yield and marketable yield (14.79 tha^{-1} and 14.65tha^{-1} respectively), while NPK 15:15:15 had better gross and marketable yield (17.14 tha^{-1} and 17.02 tha^{-1} respectively) and the combination of poultry droppings and NPK15:15:15 resulted in the best performance in gross and marketable yield (22.15 tha-1 and 22.04 tha-1 respectively).The net return (₦6,211,800 ha^{-1}) and benefit cost ratio (3.37) were maximum in the treatment with the combination of poultry droppings and NPK15:15:15.
Keywords: Poultry droppings, NPK, growth, yield and Carrot

Introduction
Carrot (*Daucus carota* L.) is an important vegetable which is ranked third among the succulent vegetables in world production (Yamaguchi, 1983). The edible roots are nutritious and contain water, protein, ash, vitamins and mineral (Norman, 1992). Carotene which is extracted from the roots is used in colouring margarine and for improving the colour of egg yolk when added to layer feed. The leaves and mature roots are used in the preparation of animal feed (Kahangi, 2004). Carrot which belongs to the family Apiaceae is a biennial and is usually cultivated as an annual crop in the tropics (De Lannoy, 2001). The crop is tolerant to soil pH of 5.5 to 6.5 and it requires a deep and well-drained loamy soil with high amount of organic matter (Yayock *et al*., 1988). Carrot production can be a beneficial enterprise for small-scale farmers because it is a short duration crop and higher yields can be obtained per unit area (Ahmad *et al*., 2005). However, Sarkindiya and Yakubu (2006) reported low average yields in Nigeria. In most developing countries, carrot yield per unit area remains below the world average (FAO 1999). One reason for low yield is low soil fertility and low technological know-how in production methods. In order to obtain high and sustainable carrot yields, good soil fertility and constant growth are required to facilitate production and translocation of carbohydrates from leaves to roots. The key limiting factors in crop growth, development, and yield are nitrogen, phosphorous, potassium, and water. In most cases, carrot growers use chemical fertilizers as the major supply of nutrients to attain higher growth and yield (Hochmuth *et al*., 1999; Amjad *et al*., 2005). Continuous application of synthetic fertilizer may lead to soil acidity, human health problems, and soil degradation because they release nutrients at a faster rate. Increasing costs of synthetic fertilizers have made them generally unaffordable to most small-scale farmers. Fordham and Biggs (1985) recommended the application of 70-120 kg/ha N, 30- 35 kg/ha P and 0-55 kg/ha K for high yield of carrots. Application of 300 - 450 kg/ha NPK (15:15:15) before planting has been recommended for improved growth and yield of the crop (Norman, 1992). Kahangi (2004) has

recommended the application of 10-20 t/ha poultry manure for improved growth and yield of carrot in the tropics. However, there is not much work on this study in Nigeria. The present research was therefore, undertaken to determine the effects of inorganic fertilizers and organic poultry droppings on the growth and yield of carrot.

Materials and Methods

The experiment was carried out at the Faculty of Agriculture demonstration farm, University of Port Harcourt. Soil samples of the experimental plot were collected and analyzed. The seeds were sourced from Songhai farm Sapele Delta State. The carrot seed is a Thema variety and the fertilizers (NPK 15:15:15 and poultry droppings) used were provided by the Faculty of Agriculture demonstration farm, University of Port Harcourt. The experiment was laid out in a completely randomized design of four treatments with three replications. The four treatments used in this experiment are as listed thus;
Treatment 1: poultry droppings (organic fertilizers)
Treatment 2: NPK 15:15:15 (inorganic fertilizers)
Treatment 3: combined effect of organic and inorganic fertilizers (poultry droppings and NPK)
Treatment 4: no fertilizer (control)
Carrot seed were soaked in water for 24hrs and wrapped with a cloth for 5 hrs (Shahid *et al.*, 2011). Beds were made and seed were sown at a spacing of 25cm x 25cm at a depth of 1.5cm. 35days after sowing, the treatments were applied; poultry dropping, NPK and combined effect of poultry droppings and NPK were applied on the plot using mechanical ring method. Two thinning operations were done at 25 and 35 days after sowing of seed to maintain the spacing. The experimental plot was kept free from infestation by weed. Intercultural and irrigation operations were carried out when required. The carrots were harvested 90 days after sowing. The crop was disease free and no fungicide were used. The following parameters were analyzed: number of leaves, plant height, diameter of root, length of root, fresh weight of roots, dry weight of roots, fresh weight of leaves, dry weight of leaves, gross yield, and marketable yield. The leaves of the plant of the various treatments were counted visually. The number obtained was then recorded appropriately against each sample. The plant height was measured with a metre tape in centimetres from the soil surface to the plant apex. The diameter of the root was measured at the thickest portion of the root at harvest. This was done using slide clippers. Marketable yield of the root was computed from conversion of the total marketable roots per plant and was recorded in hectares. Data collected for each parameter were subjected to analysis of variance (ANOVA) using Microsoft Excel 2010 version. Means were compared using the least significant Difference (LSD) (Steel and Torrie,1960).

Results and Discussion

The results of the effects of Poultry dropping and NPK 151515 on the number of leaves are shown in fig.1. From the result, after application of treatments, there was significant P=0.05 difference in number of leaves. At week 12, the highest number of leaves was recorded in the combination of NPK 15:15:15 and Poultry droppings (11.97), followed by NPK 15:15:15(11.63) and poultry dropping (11.27). The effect of increased number of leaves was as a result of the quick release of nutrients from the combination of NPK15:15:15 and poultry droppings that enhanced the soil conditions, which might have increased the number of leaves. Generally the control showed lowest number of leaves.

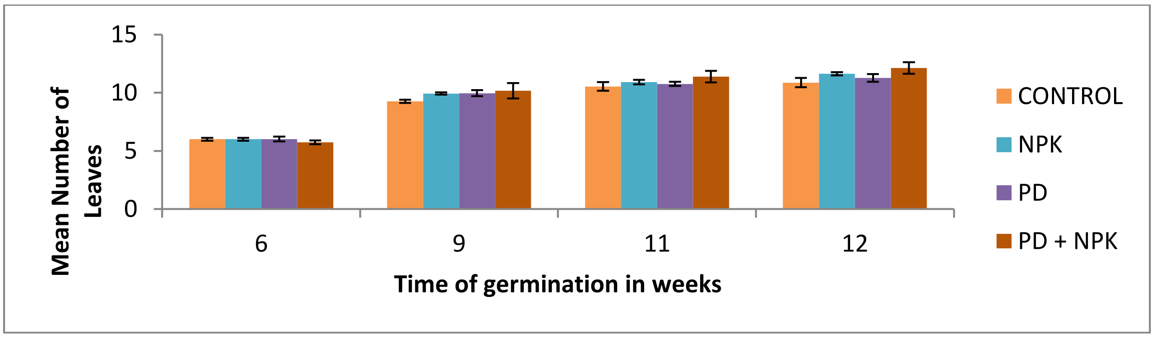

Fig.1: Eefects of Poultry Droppings (PD) and NPK15:15:15 on number of Leaves

The Plant height varied significantly P=0.05 with the application of the poultry droppings, NPK 15:15:15 and their combination (poultry droppings and NPK15:15:15). At 12 weeks the highest plant height (61.67cm) was found with NPK15:15:15 and poultry droppings treatment, followed by poultry dropping (59.50 cm), NPK 15:15:15 (56. 33cm) and the shortest height were found in control (53.33cm) Fig. 2.

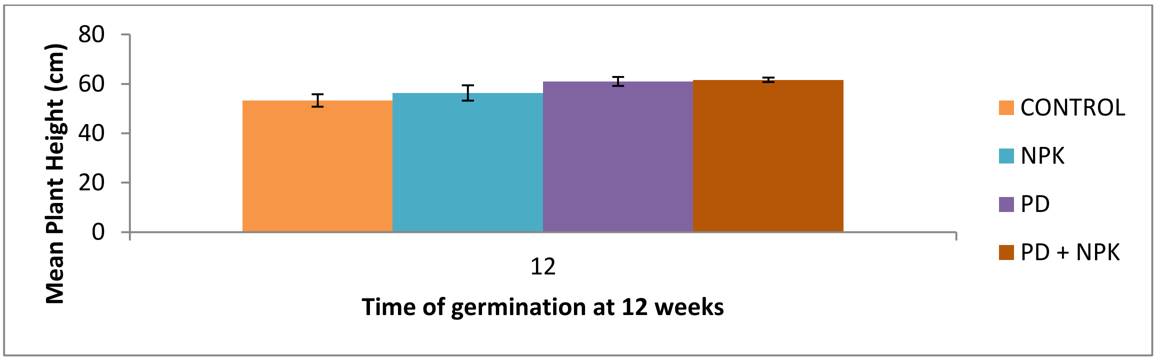

Fig 2: Effect of Poultry Droppings (PD) and NPK 15:15:15:15 on Plant Height

The maximum leaf weight per plant was recorded in the combination of poultry droppings and NPK15:15:15 (138.44g) followed by NPK15:15:15 (107.15g) and poultry droppings (92.43g) and the control were recorded to have the minimum weight (84.91g). The combination of poultry droppings and NPK15:15:15 were found to have the maximum weight; this is due to the adequate supply of nutrient leading to higher vegetative growth of the plant. The fresh weight of root per plant was significantly P=0.05 different with respect to the treatments (Table 1). The highest fresh weight of root per plant was found in the combination of poultry droppings and NPK15:15:15 (64.55g) followed by NPK15:15:15 (53.54g) and poultry droppings (46.04g) while the lowest weight (38.09g) was found with control. This may be due to the fact that the combination of the fertilizers supports the soil physical condition for better development. The maximum dry weight of leaves was found in control (17.94%) followed by poultry droppings (16.94%) and NPK15:15:15 (16.29%) while the combination of NPK 15:15:15 and poultry droppings (15.15%) was the minimum dry weight. The maximum dry weight was found in the combination of poultry droppings and NPK15:15:15 (16.65%), followed by NPK15:15:15 (14.98%) and poultry droppings (13.86%) while the control (11.71%) had the minimum percentage of dry weight. The provision and supply of adequate nutrient for better growth by the combination of the poultry droppings and NPK15:15:15 enhanced the production of maximum amount of dry weight of the root.

Table 1: Effect of Poultry Droppings and NPK15:15:15 on the Growth and Yield of Carrot

Treatments	Length of root/plant (cm)	Diameter of root/plant (cm)	Fresh wt. of root/plant (g)	Fresh wt. of leaves/plant (g)	Percent dry wt. of roots	Percent dry wt. of leaves
NPK15:15:15+PD	16.04±0.34	5.95±0.46	138.44±5.23	64.55±3.21	15.15±0.48	15.65±3.11
POULTRY DROPPINGS (PD)	13.60±1.5	6.10±0.02	92.43±5.6	46.04±3.64	16.94±1.18	13.86±0.47
NPK 15:15:15	14.70±0.8	5.97±0.27	107.15±4.89	53.54±5.34	16.29±1.61	14.98±0.58
CONTROL	11.70±0.4	5.98±0.58	84.91±6.45	38.09±5.81	17.94±2.66	11.71±1.56

Mean±Standard Error

The cracked root production was significantly P=0.05 influenced by the application poultry droppings and the NPK15:15:15 (fig. 3). The maximum number of cracked roots (0.08) was obtained from the treatments of poultry droppings followed by NPK15:15:15 (0.07) and the combination of NPK151515 and poultry droppings (0.04) while the control had the lowest (0.03) number of cracked roots. The branched root production was significantly P=0.05 influenced by the application of poultry droppings and the NPK15:15:15. The maximum number of cracked roots (0.12) was obtained from the control followed by treatments of poultry droppings (0.07) and NPK15:15:15 the combination of NPK151515 and poultry droppings (0.04) while the combination of NPK151515 and poultry droppings had the lowest (0.03) number of branched roots.

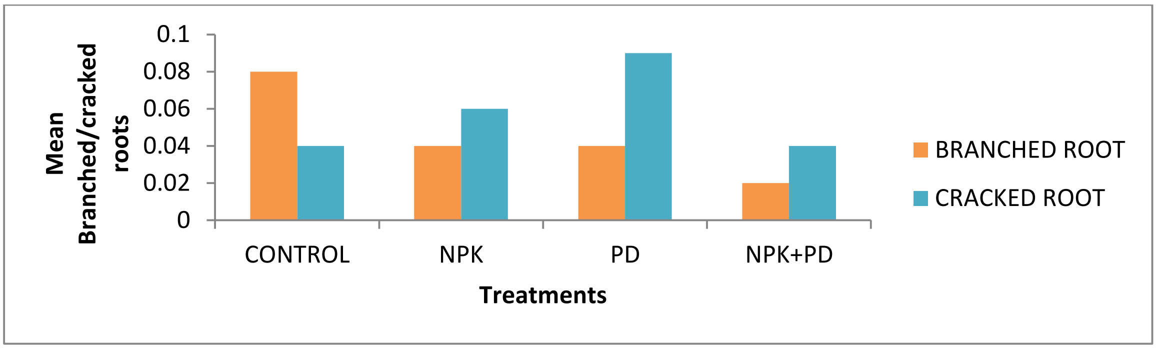

Fig. 3: Mean Branched and Cracked Roots of Carrot

Conclusion

Organic manures helps to improve the soil fertility and productivity, inorganic fertilizers also supply adequate nutrients in known proportion but on the other hand creates problem to the environment when use indiscriminately From the results of the present study, it can be concluded that the combination of poultry dropping and NPK15:15:15 is suggested for maximum carrot production.

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ASN 52nd Annual Conference Proceedings

Antibacterial Activity of Hausa Potato Leaves Extract

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Abstract
Hausa potato is an underutilized root crop with edible root and foliage. It is not only important for its significant contribution to nutrition but also a source for traditional medicine used in the treatment of dysentery. This informed our search for its antimicrobial use against Food-borne pathogens. The antimicrobial activity of Hausa potato was investigated against three Gram-negative bacteria strains; Escherichia coli, Salmonella typhi and Pseudomonas aeruginosa, two Gram-positive bacteria strains: Enterococus fecalis and Staphylococcus aureus. The antibacterial activity was evaluated by agar diffusion, minimum inhibition and bactericidal concentration methods. The antibacterial activity of the plants studied demonstrated clear zones of inhibition. The data obtained for the antibacterial activity of Hausa potato leaf is the first reported to the best of our knowledge. The extract showed sensitivity to both Gram negative and Gram positive tested bacteria strains. The results suggest that Hausa potato has potential as an antimicrobial agent

Introduction
Antibiotics have been part of animal feed since the 1950s. They are given in the form of supplement or mixed in their drinking water. There is no doubt that there is great improvement in animal growth and performance but routine use of antibiotics on farm animals can promote drug resistant bacteria. Although the drugs maybe effective against most of the bacteria killing them but there are some that could survive, proliferate and colonize in human (Linton *et al.*, 1977). In recent years the use and search for drugs and supplements of plant origin has increased tremendously. Traditional healers depend on plant sources for treatment and prevention of bacterial infection, also plants rich in phytochemicals such as terpenoids, tannins, alkaloids and flavonoids have been found to possess antimicrobial potentials. (Cowan, 1999). Hausa potato (*Solenostemon rotundifolius*) leaves possess high content of tannins and moderate amount of alkaloids and flavonoids (Harbor, *et al.,* 2016). These aromatic hydrocarbons have been shown to possess antibacterial activity (Murugan, *et al*., 2013). In view of search for antimicrobial of plant origin to be used in order to reduce the incidence of drug resistance, we carried out *in vitro* studies of antimicrobial potential of Hausa potato. The objective of the study was to determine the susceptibility of enteric microorganisms to Hausa potato leaves' extract in search of potent antimicrobials from natural product.

Materials and method
The leaves of *S. rotundifolius* was dried under room temperature, pulverised and extracted with ethanol. The anti-microbial activity of ethanol extract of Hausa potato leaves were examined against some two gram positive and three gram negative enteric micro-organisms: *Staphylococcus aureus* (+), *Enterococcus faecalis* (+), *Escherichia coli* (-), *Salmonella typhi* (-) and *Pseudomonas aeruginosa* (-). Stock solutions were prepared by dissolving 0.2 g (200 mg) each of the crude extract in 2 ml of DMSO to give concentration of 100 mg/ml. Further concentrations were obtained by performing serial dilutions to obtain 10 mg/ml and 1mg/ml. These concentrations used to evaluate the inhibitory effect of Hausa potato leaves against the selected enteric organisms. The test organisms were reactivated from nutrient agar slants onto freshly

prepared nutrient agar plates and these were inoculated into prepared Mueller-Hinton agar plates. The Kirby-Bauer disc diffusion technique was employed for the determination of the sensitivity of microorganisms to the extract. Greater drug efficacy yields larger microbe-free zones surrounding drug-containing disks after overnight growth on solid media. The broth dilution method described by Andrews (2001) was followed for the determination of the minimum inhibitory concentration (MIC), while minimum bactericidal concentration (MBC) was determined by sub-culturing MIC to culture plates that do not contain test microorganisums. Complete absence of growth was indicative of MBC. Gentamicin was used for the positive control while the negative control was DMSO.

Results and Discussion

Our earlier studies on the phytoconstituents of Hausa potato leaves reveal high content of flavonoids and tannins (Harbor *et al.,* 2016). Both tannins and flavonoids have been associated with antimicrobial activity. Flavonoids are said to be synthesized by plants in response to microbial infection (Dixon *et al.,* 1983) and have been found *in vitro* to be effective antimicrobial substance against a wide array of microorganisms. Their activity is probably due to their ability to complex with extracellular and soluble proteins and with the peptidoglycan of bacterial cell walls. However more lipophilic flavonoids are thought to disrupt microbial membranes (Cowan, 1999). Tannins antimicrobial activity may include inhibition of extracellular microbial enzymes, deprivation of the substrates required for microbial growth or inhibition of oxidative phophorylation. The extract of Hausa potato leaves showed antimicrobial activity against *S. aureus, E. faecali* and *S. Typhi* strains. No antimicrobial activity by the crude extract was observed against *E. coli* and *P. aeruginosa* strains most likely; fractions of the extract may have activity against these strains when tested. The leaves of Hausa potato can be described as broad spectrum antibiotic agent since it has anti-microbial activity on both the Gram positive and the Gram negative bacteria strains. The activity and potency of the positive control, gentamicin, is seen to be significantly higher than that of the extract and could be because it is a pure compound. Moreover in traditional use, medicinal plants are not used as single therapy, rather are used in combination with other herbal remedies thereby acting in synergistic manner and raising the potency.

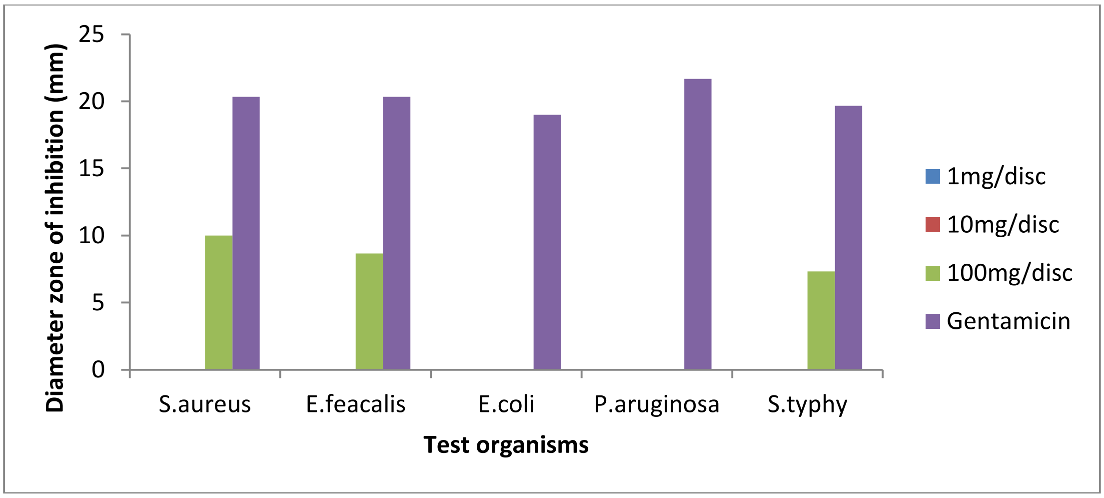

Fig1 Result of anti-microbial activity of *S. rotundifolius* leaves on *Staphylococcus aureus*

Table 1: Result of MIC and MBC

	E.coli	*S.aureus*	*E.feacalis*	*S.typhy*	*P.aeruginosa*
MIC	NI	12.5	50	50	NI
MBC	NI	25	50	50	NI

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Short-term Effect of Tillage and Bradyrhizobium Inoculation on Grain Nitrogen and Soybean Performance in Savanna Alfisol

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Abstract
The response of an improved soybean variety (TGX-1448-2E) to bradyrhizobium inoculation under different tillage systems and maize-soybean-based cropping systems in the Northern Guinea Savanna of Nigeria was evaluated at Institute for Agricultural Research, Ahmadu Bello University Research Farm, Samaru. Treatments consisted of two tillage systems; conventional tillage (CT) and reduced tillage (RT) and Bradyrhizobium inoculation [inoculated (IN) and uninoculated (UNIN)]. These were tested in a split-plot experimental design with three replications. The results showed that data obtained for dry matter yield were consistently higher in inoculated plots compared to the uninoculated plots at significant level of $P < 0.001$). Results of grains yield were similar and consistent with that of the dry matter yield (DMY). Grain yield (2481.88 kg/ha), grain N (3.98 %) and protein content (24.89 %) obtained under inoculated plots were significantly higher than uninoculated plots with 14.04 % difference. No significant difference was observed between the RT and CT in terms of grain N and protein content while reverse is the case in grain yield. The findings tend to suggest the need for Rhizobium inoculation to improve soybean growth and grain yield under good management systems.

Keywords: Tillage, Rhizobium inoculation, grain legume and Savanna Alfisol

Introduction
Tillage, one of the most important practices in agriculture, performed primarily to mix the soil with organic residues and fertilizer, to loosen the upper layer of soil, to check weeds and to create a suitable seedbed for germination and plant growth (Rasmussen 1999). Soil physical and biological characteristics are influenced by tillage practice, which in turn lead to alter plant growth and yield (Wasaya *et al*., 2011, Rashidi and Keshavarzpour 2007). Reduced soil disturbance, for example, improves soil physical parameters such as structure, and also the chemical and biological parameters that affect nitrogen fixation. Soil moisture and temperature, are known to be influenced by tillage, all of which affect biological nitrogen fixation (Salvagiotti *et al.,* 2008). According to Kemal, (2011), No-Tillage with Direct Seeding (NTDS) plots gave root weights (6.9 g/plant), number of nodules (96 number/plant) weight of nodules (0.318 g/plant) and root nitrogen content (% 0.71) which were found to be statistically higher than with the other tillage methods. In the Reduced tillage with rotary tiller (RTR) plots, the values of root dry weight (51.3 g/plant), mean nodule weight (3.91 mg/nodule), root N content (2.38%), and are found to be higher than in the NTDS plots. However, legumes such as soybean that transport N fixed from roots to shoots in the form of ureides (allantoin and allantoic acid) are particularly susceptible to water stress (Sinclair *et al*., 2007) and conservation practices involving reduced tillage and surface crop residue application, are expected to positively influence nitrogen fixation (Kihara *et al.,* 2011). Similar studies have also shown that zero and reduced soil tillage methods have increased the soil microbial activity and population. The average yield increase over ten years of research in soybean inoculation has returned a profit of over 300 percent (Beuerlein, 2004). Increases in fresh weight, dry weight and seed weight were also observed as compared to the control in several instances (Jalaluddin, 2005). The high N fixing property of soybean can be

seen in the plant coloration. Colour differences were obvious in a study, as inoculated plots appeared much greener compared to the uninoculated (Thelen and Schulz, 2009). In view of the above discussion, a field study was conducted with a view to evaluate the effect of tillage and *Rhizobium* inoculation on the performance of soybean, in a savanna Alfisol of Nigeria.

Materials and Methods

Experimental site

Field experiment was conducted at research farm of the Institute for Agricultural Research (IAR) Ahmadu Bello Univeristy, Samaru, in 2011 cropping season. Samaru (11° 11' N, 7° 381E) 686 m above sea level is located in the Northern GunieaSavanna of Nigeria with an annual rainfall of 1100 mm distributed between April and October (Kowal and Knabe, 1972) and monomodal rainfall pattern. While the longitudes (11^{o} 10' N) and latitudes (7^{o} 36' E) of the actual experimental field were determined by use of a Global Positioning System (GPS) receiver. Samaru has a long-term mean temperature of 21.05^{o}C (minimum), 33.47^{o}C (maximum), and relative humidity of 55.23 % (Oluwasemine and Alabi, 2004). The soil type is an Alfisol derived from Pre-Cambrian Crystalline basement complex rocks with some quanternary (quarternary) Aeolian deposits. The main soil sub-group is TypicHaplustalf (Awujoola, 1979).

Field experiment

The experiment was a split plot arrangement in a randomised complete block design with three replicates. The treatments were tillage practice as main plot (reduced and conventional tillage) and bradyrhizobium inoculation as sub plot (inoculated and uninoculated). The conventional tillage was ridged manually using hoe while reduced tillage was planted directly without ridging. Soybean (TGX 1448-2E) was used as a test crop. Phosphorus and potassium fertilizers were applied to all the plots at the rate of 60 kg P_2O_5 ha^{-1} and 60 kg K_2O ha^{-1} respectively, at planting without nitrogen fertilizer. Weeds were controlled by the application of glyphosate at two weeks before land preparation. Subsequently, manual weeding was employed two times before harvesting.

Inoculation and planting

The soybean seeds were surface sterilised as reported by Vicent (1970) and inoculated with commercial bradyrhizobial strain described Somasegaran and Hoben (1994). Soybean seeds were drilled in open grooves on the ridges and covered lightly with soil. The uninoculated soybean treatment rows were planted first before uninoculated plots. The seedlings were thinned to one plant per hill at 5 cm within row spacing at two weeks after planting. Subsequent field operations such as weeding were cautiously done manually to avoid transfer of rhizobia from inoculated rows to uninoculated rows.

Sampling and Analysis

Soil samples were collected at 0-20 cm depth from the experimental field before planting for determination of physicochemical properties of the studied soil. Plant within the net ridges of each plot at harvest were cut at ground level, bagged, air-dried and manually threshed. The following measurements were obtained: weight of dry haulms, grain yield and 100 grain weight, as well as the shoot weight, root weight per plot. Grain was grounded in a hammer mill, passing through a 0.5 mm sieve and stored at -5 ^{0}C in bags for analysis nitrogen as described by micro-kjeldahl digestion method (Bremner and Mulvaney, 1982) and multiplied by a factor (5.7) to obtain protein content (Halvorson *et al.,* 2004).

Statistical analysis

Data were subjected to analysis of variance (ANOVA) using mixed linear model MIXED Procedure of SAS, (Institute Inc., 2009). The effects of various factors and their interactions were compared by computing least square means and standard errors of difference (SED) at 5 % level of probability.

Results and Discussion

Dry Matter Yield

Effects of tillage systems on root dry matter yield were not significant (Table 3). However, effect of inoculation resulted in significant different in root dry mater weight. The percentage difference between inoculated soybean and uninoculated ones was found to be 11%. The interaction effects, was not significant. There was also no significant difference between the tillage systems on shoot dry matter of the soybean plant. There was however, highly significant difference ($P<0.001$) as a result of inoculation effect on shoot dry matter. The obtained difference as 16% inoculated soybean was always superior in all cases. The haulm dry matter on the other hand recorded a highly significant difference (P<0.01) as influenced by the tillage systems, with CT being 11% higher than RT. More dramatic ways the highly significant difference (P<0.05) recorded as a result of Rhizobium inoculation. Inoculated soybeans recorded a higher haulm dry matter compared to the uninoculated with percentage difference of 10.79%. There was also significant difference between (P<0.05) the Tillage*Rhizobium inoculation interaction (Fig.2). The percentage contrast was 18.14%. A significant differences observed in the dry matters yield of the inoculated soybean over uninoculated plots were due to the effectiveness of the Rhizobium inoculant used. The findings are in conformity with that of Bai *et al*. (2002) and Okereke *et al.* (2004) reported 29% and 2 - 130% increase in SDW following the inoculation with *Rhizobium*, respectively. Egamberdiyeva et al. (2004) reported that *Rhizobium* inoculation increased soybean SDW and RDW by 7-23% and 57-78%, respectively. Sobral *et al.* (2004) explained that use of r*hizobia* isolates were able to produce IAA, solubilize phosphate and fix nitrogen which could be used for soybean growth promotion.

Table 3. Effect of tillage and Rhizobium inoculation on dry matter yield

Treatment	Root Dry Matter (kg/ha)	Shoot Dry Matter (kg/ha)	Haulm Dry Matter (kg/ha)
Tillage systems			
CT	653.87	1624.44	4237.11
RT	657.59	1605.28	3804.55
Mean	655.73	1614.86	4020.83
SE±	30.26	31.48	102.91
Rhizobium Inoculation			
Inoculated	690.74	1735.56	4226.66
Uninoculated	620.71	1494.17	3815.00
Mean	655.73	1614.86	4020.83
± SE	30.26**	31.48**	102.91**
Tillage*Rhizobium Inoculation			
Significance	NS	NS	*

NS= not significant, * = Significant at 5 % probability, SE= standard error, CT= conventional tillage, RT= reduced tillage

Hundred seeds weight was significantly differenced (P<0.05) by the tillage system (Table 4). Also, significant difference (P<0.05) was between Rhizobium inoculation and uninoculated soybeans plots in terms of 100-seeds weight. The Tillageand Rhizobium inoculation interaction was not significant. However, tillage systems significantly influenced grain yield, Inoculated soybeans gave much higher grain yield compared to the uninoculated ones. The percentage difference between the inoculated and uninoculated soybeans was 35.51% (Table 4). The Tillageand Rhizobium inoculation interaction was not significant on grain yield. The final grain yield of a crop is a function of cumulative contribution of its various growth and yield parameters which are influenced by various agronomic practices and environmental conditions. Higher grain yield (2481.88 kg ha^{-1}) was obtained from soybean seed inoculated with *Rhizobium* compared to the un-inoculated (1357.11 kg ha^{-1}).

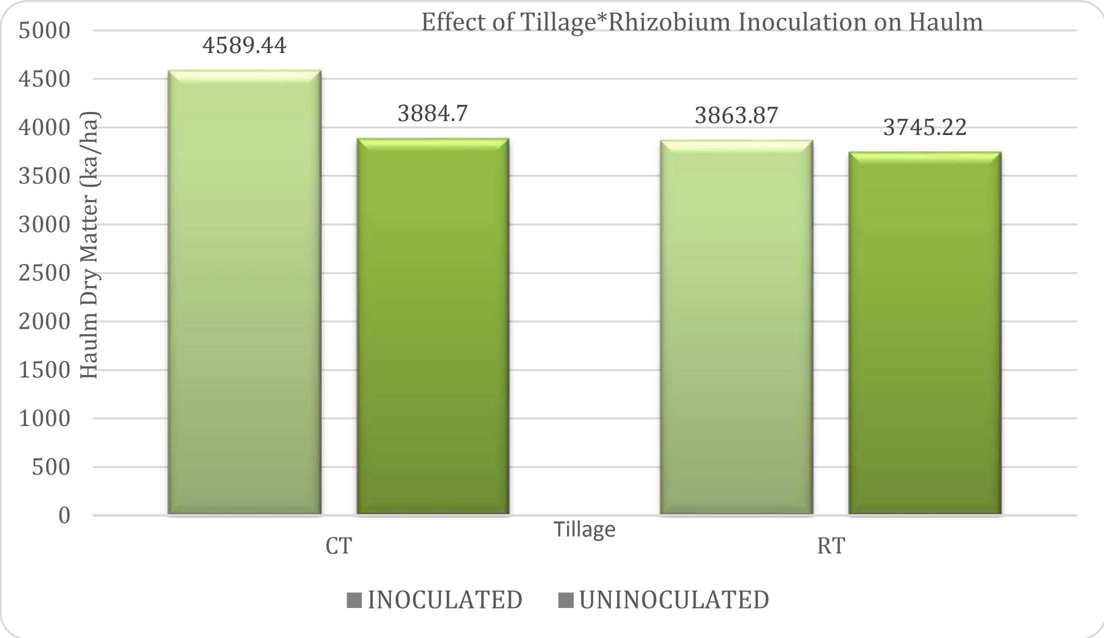

Fig. 2 Interaction Effect of Tillage and Rhizobium inoculation on Haulm Dry Matter
100-Seed Weight and Grain Yield

Symbiosis between soybean and *Rhizobium* inoculation can be the possible explanation to the above findings. Increased nodulation resulted in more N fixation that led to increased yield components. Increase in pods number, seed and dry matter yield due to *Rhizobium* inoculation was well documented in literature. Okereke *et al.* (2004) reported 14 – 100 %, Egamberdiyeva *et al.,* (2004) 48 - 55%, (Majid *et al.,* 2009) 41-62 % increases in seed and dry matter yield due to inoculation. Similarly, Ashraf *et al.,* (2002), Oad *et al.,* (2002) and Abbasi *et al.,* (2008) in Pakistan, reported increase in seed yield due to *Rhizobium* inoculation. Mendels *et al.,* (2003) reported higher yield of soybean (3514 kg/ha) in conventional tillage than that of No-tillage (3224 kg/ha).

Grain Nitrogen (N) and Protein Content

The computed total grain N and protein content are presented Table 4. The result shown that tillage system did not significantly ($P<0.05$) influence the grain N concentration as well as protein content. However, there was highly significant difference ($P<0.0001$) between the inoculated and uninoculated soybeans in terms of total grain N and protein content. The magnitudes of the difference were 14.04% total grain N and 14.50 % protein with inoculation stimulating the higher performance. The Tillageand Rhizobium inoculation interaction was not significant. The higher total grain N and protein content recorded in inoculated plots was due to effectiveness of the Rhizobium inoculant used. The significant increase in nodulation resulted in greater N fixation (Seneviratne *et al*., 2000; Sarr *et al.,* 2005; Majid *et al.,* 2009). Similar observation was recorded by Majid *et al.,*(2009). They reported that Rhizobium inoculation increased soybean seed N by 9 % over uninoculated control and 10% increase in protein content and 19% increase in oil content of soybean following the inoculation of *Rhizobia.*

Table 4. Effect of treatment on grain yield and 100-seed weight

Treatment	100-Seeds weight (g)	Grain Yield (kg/ha)	Grain N (%)	Protein (%)
Tillage systems				
CT	14.87	1667.09	3.69	23.05
RT	14.15	1501.90	3.77	23.57
Mean	14.51	1584.50	3.73	23.32
± SE	0.13	76.38	0.07	0.41
Rhizobium Inoculation				
Inoculated	15.73	1811.88	3.98	24.89
Uninoculated	14.29	1357.11	3.49	21.74
Mean	14.51	1584.50	3.74	23.32
± SE	0.13*	76.38**	0.07***	0.41***
Tillage*Rhizobium Inoculation				
Significance	NS	NS	NS	NS

NS= not significant, SE= standard error, CT= conventional tillage, RT= reduced tillage.

Conclusion

It can be concluded from the study that the data computed for grain yield (2481.88 kg/ha), root dry weight (690.71 kg/ha), shoot dry weight (1735.56 kg/ha), haulms dry weight, grain N (3.98 %) and protein content (24.89 %) were consistently higher in Rhizobium inoculation plots compared to the uninoculated ones. While the influenced of reduced tillage system was lower in terms of nodulation, yield and dry matter yield but higher in root dry matter weight (657.50 kg/ha) compared to conventional tillage system with root dry matter weight of 653.86 kg/ha. There was interaction effect of tillage and rhizobium inoculation on haulm dry matter only. The study revealed the agronomic important of using Rhizobium inoculation in soybean production under tillage system in other to boast smallholder farmers income in northern Guinea savanna of Nigeria who are characterised by intensive cultivation coupled with low input use and low capital base.

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Effects of Antitranspirants on the Growth Characters of Moisture Stressed Tomato (*Solanumlycopersicon*L.) at Kano in Sudan Savana of Nigeria

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Abstract

Salicylic acid and Benzoic acid are antitranpirantsusually used to reduce the rate of moisture loss and increase productivity of irrigated crops. To test antitranspiracy of Salicylic and Benzoic acids, field experiments were conducted during the two successive dry Seasons of 2011/2012 and 2012/2013 at the Teaching and Research Farm of Faculty of Agriculture Bayero University, Kano (11° 97' 98.6" N, 8°42' 03.7" E) 475 m elevation. The aim was to study the effects of antitranspirants and moisture stress on crop growth and development stages of tomato. The treatments consisted of two antitranspirants at four concentrations each (0, 200, 400 and 600 ppm) and three moisture stress stages (vegetative, flowering and fruit setting). Antitranspirants and moisture stresses were assigned to the main plot and concentrations were used as sub–plot treatment. These were replicated three times and laid out in a split-plot design. The gross plot size was 3.6m x 3.0m (10.8m^2) consisting of 6 rows of 3m length, while the net plot size was 1.2 m x 1.8 m (2.16 m^2) consisting of 2 inner most rows. Data were taken on some tomato growth attributes. Data generated were analysed using SAS. The results of the study revealed that application of Salicylic acid at 600 ppm significantly enhanced leaf area, total dry matter, crop growth rate and relative growth rate than application of Benzoic acid.Interaction between antitranspirant and stress was significant on dry matter. Flowering and fruiting stages were found to be the critical growth stages for moisture stress of tomato.

Keywords: Antitranspirant, moisture stress, growth characters and tomato

Introduction

Besides chilling and freezing temperatures, drought is one of the most important limiting factors of crop production all around the world.Cultivation of tomato is now widespread throughout the temperate and tropical climate (Harlan, 1984). It is among the most important vegetable crops in Nigeria. Large scale tomato production in Nigeria is mainly under irrigation during the dry season. Tomato is a rich source of vitamin A, B and C with acidic properties that bring out other flavour (Rakesh and Adarsh, 2010). Tomatoes require a high water potential for optimal vegetative and reproductive development. Therefore, irrigation is required for profitable production.There is a critical need to balance water availability, water requirement and water consumption in conserving water which has become a decisive consideration for agricultural expansion, particularly in arid and semi- arid regions.One way to achieve this goal is by reducing the transpiration rate using Antitranspirant materials to minimize the amount of irrigation water. Foliar application of antitranspirant seams an attractive method for regulating transpiration and maintaining a favourable plant water status.

Materials and Method

The experiment was conducted for the two successive dry seasons of 2011/2012 and 2012/2013 at the Teaching and Research Farm of Faculty of Agriculture Bayero University, Kano (11° 97' 98.6" N, 8° 42' 03.7" E) 475 m above sea level. The treatments consisted of two antitranspirants (Benzoic and Salicylic acids) at four concentrations each (0, 200, 400 and 600 ppm) and three moisture stress stages (vegetative, flowering and fruit setting). The experiment was laid out in a split-plot design and replicated three times.The land was ploughed, harrowed and prepared into plots of slightly sunken beds of 3.6 m x 3.0 m (10.8m^2) sizes. Paired rows of beds were separated by 0.75m wide irrigation channels between the plots.Before removing the seedlings from the nursery, thebedswere thoroughly irrigated and seedlings were uprooted using a small hand hoe and then transplanted at a spacing of 60 cm x 60 cm.Salicylic and Benzoic acids were sprayed to the foliage using a hand sprayer at vegetative, flowering and fruit setting stages at the rate of 0, 200, 400 and 600 ppm equivalent to 0.2, 0.4 and 0.6 g L^{-1} of water.

Results and Discussion

Table 1 shows that Antitranspirant had significant effect on the leaf area and dry matter of the moisture stressed tomato where plants that were foliar sprayed with salicylic acidhad wider leaf area (9.48cm^{-2}) than those sprayed with benzoic acid (8.89cm^{-2}). The effect of stress was observed to be significant where plants that were stressed at fruiting stage had wide leaf area (9.27cm^{-2}) while those stressed at flowering and vegetative stages had narrow leaf areas (7.42cm^{-2}) and (7.42) respectively. Application of 600ppm resulted into plants with wider leaf area (9.85cm^{-2}), although statistically at par with 200ppm (9.53cm^{-2}).Similarly, foliar applied salicylic acid produced plants with higher dry matter (100.47g) than benzoic acid (98.22g). Plants stressed at fruiting stage had higher dry matter (103.45g) while those stressed at vegetative stage had lower dry matter (79.12g) and plants sprayed with 600ppm concentration had higher dry matter (110.66g) than the control 0ppm (80.22g). Interaction between antitranspirant and stresson the dry matter of moisture stressed tomato was significant (Table 1). Table 2 shows the interaction between Antitranspirants and stress stages on dry matter of moisture stressed tomato. In 2012 season, looking at the Antitranspirants under different stress stages, application of Benzoic acid at all the stress stages significantlyhad plants with higher dry matter (107.41 g) even though at par with application of Salicylic acid at flowering (96.50 g) and fruiting stages (105.75 g).When the stress stagesare considered,stressing theplant at vegetative stage with application of Salicylic acid had significantly lower dry matter (65.41 g). Table 3 shows that there was significant difference between the antitranspirants on the crop growth rate and relative growth rate of moisture stressed tomato where application of salicylic acid resulted into plants with higher crop growth rate (3.47) while those sprayed with Benzoic acid had lower crop growth rate (2.75)in both seasons and combined. Plants stressed at fruiting stage had higher crop growth rate (9.99) than those stressed at vegetative stage (2.72). Effects of concentration of antitranspirant was observed to be significant where plants that were foliar sprayed with 600ppm had higher crop growth rate (8.17), although statistically at par with 400ppm (7.53) while the control 0ppm resulted into plants with lower crop growth (3.35). Interaction between the treatments was not significant. Similarly plants sprayed with salicylic acid had higher relative growth rate (0.49) while those sprayed with benzoic acid had lower relative growth rate (0.39) in both seasons and combined.Stress had significant effect where plants that were stressed at fruiting stage had higher relative growth rate (0.78) than those stressed at vegetative stage (0.40) and application of 400ppm concentration produced plants with higher relative growth rate (0.69), although at par with 600ppm (0.63) while plants sprayed with 200ppm had lower relative growth rate (0.47) which was at par with the control 0ppm (0.53). Interaction between treatments on relative growth rate was no significant. Table 4 shows the effect of the antitranspirants on the net assimilation rate of moisture stressed tomato. There was significant difference between the two antitranspirants on the net assimilation rate of moisture stressed tomato where foliar applied salicylic had resulted into plants with higher net assimilation rate (0.12) than those sprayed with benzoic acid (0.09). There was no significant difference between the stress stages, concentrations as well as the interactions between the treatments on the net assimilation rate of the moisture stress tomato.

Salicylic acid gave higher leaf area at in both seasons than Benzoic acid. Higher performance of Salicylic acid than Benzoic acid could be attributed to the differences of the active ingredient in the formulation of the antitranspirants. The active ingredient in Benzoic acid was 0.3 kg a.i while that of Salicylic acid was 0.95 kg a.i. Similar result was observed by Latimer (1992) who reported that application of GA_3 increased leaf area. This findings are in contrast with the results of El-Kobbia and Ibrahim (1986) who did not observe any effect on leaf area of tomato plants sprayed with Epoxylin seed oil and vapour guard antitranspirants. Total dry matter increase with Salicylic acid than Benzoic acid in both seasons. This may probably be due to the fact that, Salicylic acid might have affected assimilate transportation to the various organs positively than the Benzoic acid. Irmak *et al.* (1999) found that plant development and dry matter production for the vegetative parts of tomato plants were increased by antitranspirants. Application of Salicylic at fruit setting stage had higher dry mater possibly because of higher number of branches recorded by this antitranspirant at this stress stage. Gu*et al.* (1996) had earlier reported that water stress and antitranspirant GLK-8924 interacted on tomato to affect plant growth rate and hence dry matter. Salicylic acid had higher crop growth rate than Benzoic acid. This higher performance of Salicylic acid than Benzoic acid could be attributed to the higher leaf area and higher total dry matter obtained from plants that were sprayed Salicylic acid. Salicylic acid had produced plants with the highest relative growth rates than Benzoic acid. This results supported the findings of Goreta*et al.* (2007) who reported thatrelative growth rate of pepper was reduced by aminoethoxyvinlglycinetreated plants to 40% and 50% respectively, compared with control plants while enhanced relative growth rate was found after aminoethoxyvinlglycine and vapour guard application.The higher performance of Salicylic acid in terms of net assimilation rate of tomato than Benzoic acid could be attributed to the net effect of Salicylic acid on crop growth rate and the relative growth rate.This result is in contrast with that of Cantore*et al.* (2009) who reported that applicationof Kaolin based particle film on tomato reduced net assimilation rate by 26%.

Table 1: Effect of Antitranspirants on Leaf Area (cm^2) and Dry Matter (g) of Moisture Stressed Tomato at Bayero University, Kano in 2012, 2013

Treatments	Bayero University, Kano					
	Leaf Area			Dry Matter		
	2012	2013	Combined	2012	2013	Combined
Antitranspirants (A)						
Benzoic acid	8.89b	7.86b	8.37	100.47b	132.77b	116.62b
Salicylic acid	9.48a	8.30a	8.89	98.22a	169.47a	129.34a
Level of significance	*	*	NS	**	**	**
SE±	0.178	0.194	0.328	2.340	2.520	2.010
Stress (S)						
Vegetative	8.86	7.42b	8.20b	79.12b	127.45c	103.29b
Flowering	9.46	7.42b	8.44b	101.95a	151.29b	126.62a
Fruit setting	9.24	9.27a	9.25a	103.45a	174.62a	139.04a
Level of significance	NS	*	*	**	**	**
SE±	0.178	0.194	0.328	2.340	2.520	2.010
Concentrations ppm (C)						
0	8.38b	7.86	8.12	80.22c	117.77d	99.00c
200	9.53a	8.20	8.87	93.88b	152.88b	123.38b
400	8.98ab	8.32	8.65	94.61b	130.21c	112.41bc
600	9.85a	7.92	8.88	110.66a	203.61a	157.13a
Level of significance	*	NS	*	**	**	**
SE±	0.205	0.158	0.151	2.700	2.060	1.5140
Interactions (I)						
A x S	NS	NS	NS	**	**	NS
A x C	NS	NS	NS	NS	**	NS
S x C	**	*	NS	**	**	NS
A x S x C	NS	NS	NS	NS	NS	NS

Means followed by the same letter (s) in a column are not statistically different at 5% level of probability using Student-Newman Keuls Test. *=significant at 5%; **= significant at 1%; NS = not significant

Table 2: Interaction between Antitranspirant and Stress stage on Dry Matter (g) Plant^{-1}of Tomato at Bayero University, Kano and Kadawa in 2012 and 2013

Antitranspirant	Stress stage		
	Vegetative	Flowering	Fruit setting
	BUK 2012		
Benzoic acid	92.83a	107.41a	101.16a
Salicylic acid	65.41b	96.50a	105.75a
SE+	2.485		
	BUK 2013		
Benzoic acid	127.07c	126.91c	144.33c
Salicylic acid	127.83c	175.66b	204.91a
SE+	2.52		

Means within and across column followed by the same letter (s) are not significantly different at 5% level of probability using Student-Newman-Keul

Table 3: Effect of Antitranspirant and Moisture Stress onCrop Growth Rate (g wk^{-1}) and Relative Growth Rate (gg^{-}wk^{-1}) of Moisture Stressed Tomato at Bayero University, Kano in 2012 and 2013

Treatments	Bayero University, Kano					
	Crop Growth Rate (g wk^{-1})			Relative Growth Rate (gg^{-}wk^{-1})		
	2012	2013	Combined	2012	2013	Combined
Antitranspirants (A)						
Benzoic acid	2.75b	2.88b	2.82b	0.39b	0.42b	0.41b
Salicylic acid	3.47a	9.06a	6.26a	0.49a	0.74a	0.62a
Level of significance	*	**	**	*	**	**
SE±	0.325	0.361	0.194	0.042	0.033	0.024
Stress (S)						
Vegetative	2.98	2.72c	2.85b	0.41	0.40c	0.41c
Flowering	3.27	5.20b	4.23b	0.46	0.55b	0.51b
Fruit setting	3.09	9.99a	6.54a	0.45	0.78a	0.62a
Level of significance	NS	**	**	NS	**	*
SE±	0.325	0.361	0.194	0.042	0.033	0.024
Concentrations ppm (C)						
0	2.81	3.35c	3.82	0.40	0.53b	0.46
200	3.41	4.83b	3.38	0.48	0.47b	0.48
400	3.06	7.53a	5.30	0.43	0.69a	0.56
600	3.16	8.17a	5.66	0.45	0.63a	0.54
Level of significance	NS	**	NS	NS	*	NS
SE±	0.375	0.295	0.216	0.049	0.027	0.026
Interactions (I)						
A x S	NS	NS	NS	NS	NS	NS
A x C	NS	NS	NS	NS	NS	NS
S x C	NS	NS	NS	NS	NS	NS
A x S x C	NS	NS	NS	NS	NS	NS

Means followed by the same letter (s) in a column are not significantly different at 5% level of probability using Student-Newman Keuls Test. *=significant at 5%; ** = significant at 1%; NS = not significant

Table 4: Effect of Antitranspirants on Net Assimilation Rate ($gcm^{-2}wk^{-1}$) of Moisture Stressed Tomato at Bayero University, Kano in 2012, 2013

Treatments	Net Assimilation Rate		
	2012	**2013**	**Combined**
Antitranspirants (A)			
Benzoic acid	0.08	0.09b	0.08
Salicylic acid	0.09	0.12a	0.10
Level of significance	NS	*	NS
SE±	0.007	0.012	0.019
Stress (S)			
Vegetative	0.09	0.09	0.09
Flowering	0.08	0.11	0.09
Fruit setting	0.08	0.12	0.10
Level of significance	NS	NS	NS
SE±	0.007	0.012	0.019
Concentrations ppm (C)			
0	0.07	0.11	0.09
200	0.09	0.11	0.10
400	0.08	0.12	0.10
600	0.08	0.09	0.09
Level of significance	NS	NS	NS
SE±	0.007	0.007	0.008
Interactions (I)			
A x S	NS	NS	NS
A x C	NS	NS	NS
S x C	NS	NS	NS
A x S x C	NS	NS	NS

Means followed by the same letter (s) in a column are not significantly different at 5% level of probability using Student-Newman Keuls Test. *=significant at 5%; **= significant at 1%; NS = not significant

Conclusion

It could be concluded that application of Salicylic acid at 600 ppm significantly enhanced leaf area, total dry matter, crop growth rate and relative growth rate than application of Benzoic acid.Flowering and fruiting stages were found to be the critical growth stages for moisture stress of tomato in the study area.

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Evaluation of Different Irrigation Frequencies for sustainable Sweetpotato Vine Production in the Humid Rainforest Zone of Southeastern Nigeria

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Abstract
A 5X2 factorial experiment was conducted at the screen house of the National Root Crops Research Institute, Umudike, Nigeria (latitude 05⁰, 29′ N and Longitude 07⁰ 33′ E) to evaluate the effect of different irrigation frequencies for sustainable sweetpotato pre-basic seed production in the humid rainforest zone of Nigeria. The factors were five irrigation frequencies (daily, 2 days interval, 3 days interval, 4 days interval, and 5 days interval) and two varieties of sweetpotato (TIS 87/0087and UMUSPO/3 (Mothers Delight) laid out in completely randomized fashion (CRD) and replicated 3 times. Five kilogram of the soil sample used for the experiment was weighed into 30 plastic buckets to which 1.6 liters of water was added to irrigate to field capacity. Subsequent irrigations were carried out as specified above. Growth parameters and vine multiplication rates were assessed at 4, 8 and 12 WAP. Results of the study showed that irrigating every three days interval proved to be superior in all the parameters assessed. Delaying irrigation beyond 3 days resulted in drastic reduction in the number of branches, vine length and number of cuttings. The number of cuttings and number of branches increased significantly in the 2nd cutting. The number of cuttings of TIS 87/0087 was greater than that of UMUSPO/3. For sustainable pre-basic seed production in the study area irrigating every three days is recommended. This will not only save cost but reduce the labour involved in vine production as well as other physiological defects that might arise due to over or under irrigation

Keywords: Irrigation frequency, vine production, sweetpotato and Nigeria

Introduction
Sweetpotato (*Ipomoea batatas* (L.) Lam) is a root crop widely grown in different parts of the world. It is an important food crop in tropical and sub-tropical regions of the world, particularly in Asia, Africa, and the Pacific (Osiru *et al*., 2009; Amante and O'Sullivan, 2012). Within the African cropping systems, sweetpotato has several advantages. It produces food in a relatively short time, gives reliable yields in sub-optimal growth conditions, requires lower labour inputs (appropriate for vulnerable households) than other staples, serves as an alternative food source for urban populations facing increasing prices of cereals, and provides a potential option to reduce vitamin A deficiency (Andreas *et al*.,2009). Constraints to production of sweetpotato include pests and diseases, drought, vine scarcity, lack of capital, high labour requirements, poor yields, low prices, destruction of crops by animals, lack of land and crop rotting. Of all the highlighted problems, the third most important constraint often mentioned by farmers was the availability of vines. Vines cannot be preserved for long without losing its quality. Principal sources of vines for farmers are 46% from their previous crop, 31% from friends and neighbours and only 14% are purchased (Yanggen and Naguja, 2006). According to Nabiswa and Wesonga (2009), cuttings cannot be kept for more than seven days beyond which condition that leads to large reduction in storage root yield sets in. Sweetpotato has been reported to be sensitive to water deficits, particularly during the establishment period including vine development (Indira and Kabeerathumma, 1988). Farmers often use the same amount of water and intervals, regardless of crop species and growth stage. But excessive irrigation of soils results in water loss and significantly increases runoff (soil erosion) from production fields, enhances soil nutrient leaching which leads to contamination of the groundwater due to fertilizers and other chemical

products (Al-Jamal et al., 2001). In addition, excessive water use increases production costs, reduces yield by affecting soil aeration, and favors the occurrence and severity of diseases and pests. On the other hand, deficient irrigation promotes a reduction of sweetpotato root quantity and lower yield due to reduced leaf area and/or reduced photosynthesis per unit leaf area (Van Loon, 1981) .Therefore for sustainable sweetpotato vine availability, determining the best time and frequency of irrigation will not only make vines available to farmers but will save the cost and drudgery involved in vine production.

This study seeks to determine the effect of different irrigation frequencies on sweetpotato vine production at Umudike, southeastern Nigeria and effect of variety on sweetpotato vine production attributes.

Materials and Methods

This study was conducted at the Research Farm of National Root Crops Research Institute Umudike, Nigeria (Latitude 05^0, 29'N and Longitude 07^0, 33'E). The experiment was a 5x2 factorial laid out in completely randomized design (CRD) and replicated three times. The treatment comprises of five irrigation frequencies (daily, 2 days interval, 3 days interval, 4 days interval, and 5 days interval) and two varieties of sweetpotato (TIS 87/0087and UMUSPO/3 (Mothers Delight). The field capacity of the soil used was determined by adding known volume of water to 1kg of soil sample until saturation and collecting the excess water until draining ceased. The quantity of water retained was then deducted by subtraction. 5kg of soil was weighed into plastic buckets to which 1.6 liters of water was added to irrigate to field capacity. Two vine cuttings were planted per bucket. After initial watering before planting, subsequent irrigations were carried out based on the frequencies specified above. Growth parameters such as: number of branches was assessed at 4, 8 and 12 WAP and vine length assessed at 4 and 8 WAP only. The establishment count was done at **2**WAP and number of vine cuttings per stand at 8 and 12WAP. Data collected were subjected to analysis of variance (ANOVA) using Genstat discovery edition 4. And significant means separated using Fishers least significant differences at 5% level of probability.

Results and Discussion

Vine establishment

Irrigation frequency significantly affected the rate of establishment. Irrigating the crop daily, at 2 and at 3 days intervals gave the same rate of establishment. However, the establishment rate declined when the crop was irrigated at 4 and 5 days intervals. Varietal differences and variety by irrigation frequency interaction did not affect the rate of vine establishment.

Number of branches

The results of the effect of irrigation frequency on the number of branches at 4, 8 and 12 WAP are shown on Tables 2, 3 and 4. The results showed that no significant difference was observed on the number of branches at 4WAP. However, irrigation frequency significantly influenced number of branches at 8 and 12 WAP. Irrigating every 3 days gave the highest number of branches at both 8 and 12 sampling periods. Variety did not significantly influence mean number of branches though TIS 87/0087 had more branches than UMUSPO/3. The number of branches of each variety seems to increase across sampling periods.

Vine length (cm)

The results of the effect of irrigation frequency on the vine lenght of sweetpotato at 4 and 8WAP are presented in Tables 5 and 6. The results showed that there were no significant irrigation frequency, variety and their interaction influences on vine length at 4 WAP, while only irrigation frequency significantly affected vine length at 8WAP with irrigating every 3 days giving the highest vine length (174.9 cm) across varieties.

Number of vine cuttings

The effects of irrigation frequency, variety and their interaction on the number of cuttings per stand at 8 and 12 WAP are presented in Tables 7 and 8. The result showed that both variety and irrigation frequency significantly affected the number of cuttings at 8 and 12 WAP. Irrigating at every 3 days interval gave the highest number of cuttings at 8 WAP (6.94) and 12 WAP (11.28). Stands of variety TIS 87/0087 gave higher mean number of vine cuttings (8.69) compared to UMUSPO/3 (7.44).

Varietal differences observed in most of the parameters studied could be attributed to differences in morphology of the varieties**.** Reduction in growth parameters of the varieties when irrigated daily or two days interval could be as a result of soil Co_2 concentrations which increases with increasing soil volumetric water content and have been reported to suppresses growth and root yield of sweetpotato (Siquinbatu *et al*, 2012)**.**With this increase in water and reduction in redox potentials, toxic compounds such as soluble Fe, Mn and acids appear which reduce growth (Yabuki and Kitaya, 1984; Wegner, 2010). Reduction in vine length, number of branches and cuttings at different sampling periods when the crop was irrigated every 4 and 5 days might be due to water deficit as reported by Van Heerdeen and Laurie (2008). Sweetpotato has been reported to be sensitive to water deficit particularly during establishment phase including vine development (Indira and Kabeerathumma, 1988), This explains why delaying irrigation up to 4 and 5 days interval had significant effect on vine establishment even when vigorous and disease free planting materials were used, Likewise, excess water during stand establishment phase can lead to reduction in growth and subsequently number of cuttings per plant. According to Ravi and Saravanan (2012), water logging impedes growth by restricting availability of oxygen in the root zone.Watering daily or at 2 days interval often created water-logging scenarios at times, and this could explain the observed lower mean vine length and mean vine cuttings between the two irrigation regimes and watering at 3 days interval. It is important to note that watering daily or at two days interval had better performances than 4-5 days interval watering. This suggests that sweetpotato plants could physiologically prefer water-logging scenario than drought occurence at early plant establishment stage.

Conclusion

Irrigating every three days interval proved to be superior in all the parameters assessed. Delaying irrigation beyond 3 days will likely result in drastic reduction in the number of branches, vine length and number of vine cuttings. Varietal differences abound in the number of cuttings that could be got from a sweetpotato stand. For sustainable pre-basic seed production in the study area, irrigating every three days is recommended. This will not only save cost but reduce the labour involved in vine production as well as other physiological defects that might arise due to over or under irrigation. This result needs to be further confirmed on-field.

Table 1: Effect of irrigation frequency and sweetpotato variety on vine establishment

	Variety		
Irrigation frequency	**UMUSPO/3**	**TIS 87/0087**	**Mean**
Daily	2.000	2.000	2.000
2 days interval	2.000	2.000	2.000
3 days interval	2.000	2.000	2.000
4 days interval	1.889	1.864	1.877
5 days interval	1.556	1.667	1.612
Mean	101.1	100.4	

LSD (0.05) Irrigation frequency = 0.083
LSD (0.05) Variety= NS
LSD (0.05) Frequency X variety = NS

Table 2: Effect of irrigation frequency and sweetpotato variety on average number of vine branches of at 4WAP

Irrigation frequency.	**Variety**		**Mean**
	UMUSPO/3	**TIS 87/0087**	
Daily	0.44	1.22	0.56
2 days interval	1.11	1.00	1.06
3 days interval	1.78	1.00	1.39
4 days interval	0.78	1.00	0.89
5 days interval	0.33	0.64	0.78
Mean	0.89	0.98	

LSD (0.05) Irrigation frequency = NS
LSD (0.05) Variety=NS
LSD (0.05) Frequency X variety = NS

Table 3: Effect of irrigation frequency and sweetpotato variety on average number of vine branches of sweetpotato at 8WAP

Irrigation frequency	Variety		Mean
	UMUSPO/3	TIS 87/0087	
Daily	2.56	3.33	2.93
2 days interval	2.44	3.44	2.94
3 days interval	3.89	3.56	3.72
4 days interval	2.00	1.00	1.50
5 days interval	0.78	1.33	1.06
Mean	2.33	2.53	

LSD (0.05) Irrigation frequency =0.54
LSD (0.05) Variety=NS
LSD (0.05) Frequency X variety = NS

Table 4: Effect of irrigation frequency and sweetpotato variety on average number of vine branches of sweetpotato at 12WAP

Irrigation frequency	Variety		Mean
	UMUSPO/3	TIS 87/0087	
Daily	5.33	7.00	6.17
2 days interval	5.33	6.89	6.11
3 days interval	7.69	8.22	7.94
4 days interval	4.78	2.44	3.61
5 days interval	2.56	4.11	3.33
Mean	5.13	5.73	

LSD (0.05) Irrigation frequency = 1.20
LSD (0.05) Variety= NS
LSD (0.05) Frequency X variety = NS

Table 5: Effect of irrigation frequency and sweetpotato variety on average vine length (cm) of sweetpotato at 4WAP

Irrigation frequency	Variety		Mean
	UMUSPO/3	TIS 87/0087	
Daily	90.5	106.7	98.6
2 days interval	116.6	104.0	110.3
3 days interval	139.8	130.2	135.0
4 days interval	94.9	63.1	79.0
5 days interval	64.1	97.9	81.0
Mean	101.1	100.4	

LSD (0.05) Irrigation frequency = NS
LSD (0.05) Variety=NS
LSD (0.05) Frequency X variety = NS

Table 6: Effect of irrigation frequency and sweetpotato variety on average vine length (cm)of sweetpotato at 8WAP

Irrigation frequency	Variety		Mean
	UMUSPO/3	TIS 87/0087	
Daily	135.3	143.9	139.6
2 days interval	136.6	162.7	149.6
3 days interval	174.1	175.8	174.9
4 days interval	90.1	89.5	89.8
5 days interval	71.7	77.6	74.6
Mean	???	??	

LSD (0.05) Irrigation frequency =19.89
LSD (0.05) Variety=NS
LSD (0.05) Frequency X variety = NS

Table 7: Effect of irrigation frequency and sweetpotato variety on average number of vine cuttings per plant at 8WAP

Irrigation frequency	Variety		Mean
	UMUSPO/3	TIS 87/0087	
Daily	4.11	6.44	5.28
2 days interval	4.46	6.33	5.44
3 days interval	5.33	8.56	6.94
4 days interval	3.00	3.67	3.33
5 days interval	2.00	2.67	2.33
Mean	3.80	5.53	

LSD (0.05) Irrigation frequency =1.310
LSD (0.05) Variety= 0.828
LSD (0.05) Frequency X variety = NS

Table 8: Effect of irrigation frequency and sweetpotato variety on average number of vine cuttings per plant at 12WAP

Irrigation frequency	Variety		Mean
	UMUSPO/3	TIS 87/0087	
Daily	10.11	10.22	10.17
2 days interval	9.11	9.78	9.44
3 days interval	10.11	12.44	11.28
4 days interval	3.78	6.56	5.17
5 days interval	4.11	4.44	4.28
Mean	7.44	8.69	

LSD (0.05) Irrigation frequency =1.506
LSD (0.05) Variety= 0.953
LSD (0.05) Frequency X variety = NS

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ASN 52nd Annual Conference Proceedings

Effect of Staking and Non-staking on Sweetpotato Vine Production

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Abstract
A 3x2 factorial experiment was conducted at the screen house of National Root Crops Research Institute, Umudike, Nigeria (latitude 05^0, 29ʹ N and Longitude 07^0, 33ʹ E) to determine the effect of staking and non-staking on sweetpotato vine multiplication ratio. The factors were three varieties of sweetpotato (UMUSPO/1, UMUSPO/3 and TIS 87/0087) and two production methods (staking and non-staking) laid out in completely randomized design (CRD) and replicated three times. Two vine cuttings were planted per pot from which one was sampled for data collection. Growth parameters such as: number of vine branches, vine length and number of vine cuttings were assessed at 8 and 12 weeks after planting (WAP). Data collected were subjected to analysis of variance (ANOVA), while treatment means were separated using Fishers Least Significant Difference at 5% level of probability. Results of the study showed that variety significantly affected the growth parameters and number of cuttings at different sampling periods. Production method (staking and non-staking) has no significant effect on the growth parameters studied except vine length at 12 WAP which was significantly affected by staking. Generally, non-staking proved to be superior to staking in the number of cuttings produced at different cutting intervals. Variety TIS 87/0087 produced the highest number of cuttings at different cutting intervals followed by UMUSPO/3 with UMUSPO/1 producing the least.
Keywords: Staking, non-staking, vine production and sweetpotato

Introduction
Despite the fact that sweetpotato is a crucial root crop with increasing annual consumption per capita in most Sub Saharan African countries, its production is limited by shortage of planting materials. According to Low *et al.* (2009), nurseries owned by smallholder farmers are small and most of them are located at small backyard spaces or near washing areas where they are irrigated by hard water. A strategy sometimes adopted by farmers to cope with the shortage of vines is to plant only a portion of their field with available vines and when these plants are well established, vine cuttings are taken from them and used to plant the next portion (Belehu, 2003). To overcome this challenge, scientists are exploring various ways of developing simple and affordable technologies that will lead to increase in the multiplication ratio of the vine cuttings. Alam *et al*. (2016) reported that staking enhances photosynthetic activities of plants due to better exposure of the foliage to sunlight and subsequent accumulation of higher assimilates. And increased the tuber yield in Dioscorea plants compared to non-staked plants (Norman *et al., 2015*) and fruit yields of tomato and cucumber compared to the yields from non-staked stands (Alam *et al., 2016*; Soweley and Damba, 2013). In sweetpotato, Afolabi *et al*. (2013) noted that staking induced flowering and can be used to facilitate hybridization for improved hybrid seed production. However, there is limited empirical information on the effect of staking and non-staking on sweetpotato vine production and hence the need for this study

Materials and Methods
This study was conducted at the screen house of National Root Crops Research Institute, Umudike, Nigeria (latitude 05^0, 29ʹ N and Longitude 07^0 33ʹ E*).* The experiment was a 3x2 factorial arrangement laid out in completely randomized design (CRD) and replicated three times. The treatments comprised of three varieties of sweetpotato (UMUSPO/1, UMUSPO/3 and

TIS 87/0087) and two production methods (staking and non-staking). Two vine cuttings were planted per pot from which one was used for data collection. Growth parameters such as: number of branches, vine length (cm) and number of cuttings were assessed at 8 and 12 WAP. The establishment count and staking was done at **2**WAP. Data collected were subjected to analysis of variance (ANOVA) using Genstat Discovery Edition 4. Treatment means were separated using Fishers Least Significant Difference at 5% level of probability.

Results and Discussion

Number of branches

The results of the effect of staking and non-staking on the number of branches at 8 and 12wap are presented in Tables 1.The results showed that variety significantly (p<0.05) affected the number of branches at 8WAP with UMUSPO/1 having the highest number of branches (2.56) followed by TIS 87/0087 with 1.78 mean number of branches. The varieties no longer exhibited significant differences in their number of branches at 12 WAP. Production method and the interaction of production method and variety did not affect the number of branches at the different sampling periods. However, production method means ranged between 1.78 and 2.04 at 8 WAP, and 2.81 and 2.96 at 12 WAP. For production method X variety interaction means, number of vine branches ranged 1.22 - 2.67 at 8 WAP, and 1.78 - 3.44 at 12 WAP.

Vine length

Variety significantly (p<0.05) affected vine length at 8 WAP with both TIS 87/0087 (220.7 cm) and UMUSPO/3 (217.4 cm) significantly longer than the vines of UMUSPO/1 (91.3 cm) (Table 2). Both means of production method and production X variety interaction showed no significat influence on on vine length. However, at 12 WAP, variety, production method, as wel as the interaction of variety and production method significantly affected vine length (Table 2). Variety TIS 87/0087 (111.8 cm) produced the highest mean vine length, followed by UMUSPO/3 and UMUSPO/1 in that order with mean vine lengths of 74.1 and 38.4 cm, respectively. Unlike as observed at 8 WAP, mean vine length was higher in staked stands (89.9 cm) compared to non-staked plants (60.7 cm). Overall, staked vines of TIS 87/0087 gave the highest mean vine length of 146.1 cm.

Number of cuttings

At 8 and 12 WAP, only variety significantly (P<0.05) influenced mean number of vine cuttings per stand (Table 3). At 8 WAP, TIS 87/0087 had the highest mean number of cuttings (16.28), followed by UMUSPO/1 (13.94) and UMUSPO/3 (11.50). At 12 WAP, same variety, TIS 87/0087 also had the highest mean number of vine cuttings of 10.72, which was significantly (P<0.05) higher than only UMUSPO/1 with 6.94 mean cuttings. At both sampling periods, production method and production method X variety interaction had no major influence on number of vine cuttings. However, production method had mean number of vine cuttings ranged 13.85 - 13.96 at 8 WAP, and 8.81 - 8.89 at 12 WAP.

Vine length or plant height of crops varies according to cultivar characteristics or genetic make-up (Soweley and Damba, 2013).This explains the significant differences observed in the vine length and number of cuttings of the three cultivars used. The non significant differences observed in the production method could be attributed to the non-conferment of any significant advantage on photosynthesis, and by extension, assimilate production, by either of the two production methods. Generally, sweetpotato often arranges its leaves in such a manner as to expose each leaf to maximum insolation as it creeps on the ground. This prevents shading. This same effect in naturally creeping sweetpotato plants is what staking confers on it. However, one would have expected the non-staked plants to have higher vine length and number of branches as it is a more natural growth environment for sweetpotato than the staked environment.

Conclusion

Results of this study showed that different sweetpotato cultivars responded differently to staking and non-staking. The erect sweetpotato type like UMUSPO/1 does not respond to staking while the spreading types (UMUSPO/3 and TIS 87/0087) respond to staking even though there are no significant differences in the vine length and number of cuttings among the production methods. This implies that farmers can adopt any of the two methods depending on the cultivar.

Table 1: Effect of variety, production method and their interaction on the number of sweetpotato branches at 8 and 12 WAP

	Variety (8 WAP)				Variety (12 WAP)			
Production method	UMUSPO/3	UMUSPO/1	TIS 87/0087	Mean	UMUSPO/3	UMUSPO/1	TIS 87/0087	Mean
Staked	1.22	2.44	1.67	1.78	3.44	3.22	1.78	2.81
Non-staked	1.56	2.67	1.89	2.04	3.11	2.78	3.00	2.96
Mean	1.39	2.56	1.78		3.28	3.00	2.39	

$LSD_{0.05}$ Production method at 8 WAP = NS; $LSD_{0.05}$ Production method at 12 WAP = NS
$LSD_{0.05}$ Variety at 8 WAP = 0.29; $LSD_{0.05}$ Variety at 12 WAP = NS
$LSD_{0.05}$ Production method X Variety at 8WAP=NS; $LSD_{0.05}$ Production method X Variety at 12 WAP = NS

Table 2: Effect of variety, production method and their interaction on the vine length (cm) of sweetpotato stands at 8 and 12 WAP

	Variety (8 WAP)				Variety (12 WAP)			
Production method	UMUSPO/3	UMUSPO/1	TIS 87/0087	Mean	UMUSPO/3	UMUSPO/1	TIS 87/0087	Mean
Staked	219.0	80.6	228.3	176.0	85.0	35.6	146.1	89.9
Non-staked	215.8	101.9	213.0	176.9	63.3	41.2	77.6	60.7
Mean	217.4	91.3	220.7		74.1	38.4	111.8	

$LSD_{0.05}$ Production method at 8 WAP = NS; $LSD_{0.05}$ Production method at 12 WAP = 10.71
$LSD_{0.05}$ Variety at 8 WAP = 7.43; $LSD_{0.05}$ Variety at 12 WAP = 13.11
$LSD_{0.05}$ Production method X Variety at 8WAP=NS; $LSD_{0.05}$ Production method X Variety at 12 WAP = 18.54

Table 3: Effect of variety, production method and their interaction on the number of sweetpotato vine cuttings at 8 and 12 WAP

	Variety (8 WAP)				Variety (12 WAP)			
Production method	UMUSPO/3	UMUSPO/1	TIS 87/0087	Mean	UMUSPO/3	UMUSPO/1	TIS 87/0087	Mean
Staked	11.78	12.89	16.89	13.85	9.33	7.11	10.00	8.81
Non-staked	11.22	15.00	15.67	13.96	8.44	6.78	11.44	8.89
Mean	11.50	13.94	16.28		8.89	6.94	10.72	

$LSD_{0.05}$ Production method at 8 WAP = NS; $LSD_{0.05}$ Production method at 12 WAP = NS
$LSD_{0.05}$ Variety at 8 WAP = 1.49; $LSD_{0.05}$ Variety at 12 WAP = 2.04
$LSD_{0.05}$ Production method X Variety at 8WAP=NS; $LSD_{0.05}$ Production method X Variety at 12 WAP = NS

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Occurrence of Resistance-Breaking Isolates of *Rice Yellow Mottle Virus* in North-Central Nigeria

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Abstract
The study was carried out to determine the resistance-breaking ability of six RYMV isolates collected from the north central Nigeria. Seven rice genotypes obtained from AfricaRice Center were used for the experiment in a Split-plot design with three replications in the screenhouse at Badeggi, Niger State. The result showed that the resistant alleles - rymv1-1 and rymv1-2, were circumvented by the six virus isolates; whereas rymv1-4/rymv2 and rymv1-3 only broke down with Mararaba-Obi and Gulu isolates at 42 DAI respectively. The breakdown of resistance appeared first as hypersensitivity reaction and later (≥ 42 DAI) as symptom expressed breakdown. Rymv1-5 found in Tog 5674 was not affected by the six virus isolates in terms of symptom expression; although, saps from earlier inoculated test plants also elicited symptoms at SES score of 5 on highly susceptible Bouake 189 during back inoculation test. Virus isolates from Obubu-Ofu and Makurdi, belonging to Ser1 reacted differently and circumvented the resistance in the conventional resistant check (Gigante) with obvious yellow mottle symptoms of RYMV at 42 DAI. The result of serological profile analysis indicated that the six virus isolates belonged to Serogroups 1 and 2 (Ser1 and Ser2). The present study has reported significant differences in the aggressiveness of isolates of same serogroup, and the overall RYMV isolates existing in north central Nigeria.
Keywords: Rice yellow mottle virus, Resistance-breaking, isolates and Nigeria

Introduction
Rice yellow mottle sobemovirus is fast becoming endemic virus disease of rice in Nigeria. Baker (1974) first reported the virus in Kenya, East Africa in mid 1960s, and numerous reports of the virus have emerged from major lowland rice growing countries in Africa (Kouassi *et al*., 2005). In Nigeria RYMV has been reported virtually in all rice growing areas in the country. The virus has been reported in rice fields at tillering and panicle initiation stages in Niger, Kano, Bauchi, Gombe, and Benue States in the north-central zone of Nigeria between 2000 and 2008 (Abo *et al*., 2002; Onwughalu *et al*., 2009). The disease survey in five southwest states of Nigeria, indicated disease incidence of 15 – 70% on farmer's fields in Lagos, Oyo, Ogun, Ekiti and Ondo States (Onasanya *et al*., 2011). Singh *et al*. (1997) also reported the disease in Akwa-Ibom, Ebonyi and Sokoto States; whereas Alegbejo *et al*. (2006) reported the virus disease incidence in Zamfara State. Moreover, the rice-leaf samples from the southeastern states of Delta, Imo and Anambra were earlier found with the virus (Awoderu, 1991). There are other reports of RYMV incidence on farmers' fields in the Northern Nigeria (Abo, 2010; Alkali *et al*., 2014); and the serogroups commonly reported like in other west African countries are the Ser 1, 2 and 3 (Fargette *et al*., 2002; Kanyeka *et al*., 2007). The characteristic symptoms of RYMV include yellow mottles, height reduction, spikelets' sterility; and in severely infected plants, dispersed and bunchy tiller formation may occur with orange coloration (Onwughalu *et al*., 2017). The top management strategies for RYMV in the field include good farm sanitation to eliminate weed hosts and vectors; and also, maintaining clean working implements. Other approaches involving cultural manipulations are also being adopted in an integrated management system. Earlier studies have identified RYMV resistance in traditional *Oryza glaberrima* subspecies, especially the cultivars Tog 5681, Tog 5672, and Tog 5675 (Ndijiondjop *et al.*, 1999; Traore *et al.*, 2006). N'Guessan *et al.*

(2001) reported negligible yield losses with the resistant cultivars Gigante and Tog 5675, when challenged with 15 isolates of RYMV in field condition. However, in the early and mid-2000s', reports of resistance breaking isolates of RYMV have emerged in some countries of Africa (Fargette *et al*., 2002; Hebrard *et al*., 2006; Traore *et al*., 2006); hence, the growing concern is the challenge that this might pose to the development of durable resistance to RYMV in the region. It is therefore necessary to identify, characterize and determine the resistance-breaking ability of RYMV isolates commonly found in Nigeria.

Materials and Methods

The experiment was conducted in a screenhouse at NCRI, Badeggi in 2016. The rice genotypes used – TOG 5681, TOG 5674, TOG 5672, IR 64, BG 90-2, Bouake 189 and Gigante, were obtained from the genetic resource unit of AfricaRice Center, Benin. Genes for resistance found with these rice genotypes were given as follows: IR 64 (rymv 1-1), Tog 5681 (rymv 1-3), Tog 5672 (rymv 1-4 & rymv 2), Tog 5674 (rymv 1-5) and Gigante (rymv 1-2) (Ndjiondjop *et al*., 1999; Silue Drissa, personal communication). The experiment was laid out in a Split-plot design, with virus isolates (RYMV) and rice genotypes constituted the two factors A (Main-Plot) and B (Sub-Plot). The levels of factor A (RYMV isolates) included a control (i.e. pure distilled water). The level of Factor B (Rice genotypes) included Bouake 189, which was used as a susceptible check, and Gigante (resistant check). The 7 x 7 factorial composed of 49 experimental units, which was replicated three times. Fresh leaves extracts from each disease isolate earlier multiplied on Bouake 189, were harvested, crushed and the sap obtained was finger-rubbed on test plants when plants were 5 weeks old (35 DAP). Carborundum (600 mesh) was added to extracts to aid virus penetration to test plants. For the control, only pure distilled water with an abrasive (carborundum) was used to rub on the plants. Visual assessment and scoring for RYMV symptom expression was done at 14, 28 and 42 Days After Inoculation (DAI) following the SES (1 – 9) score for rice at 35 DAI according to IRRI (1996). Disease severity and other agronomic data were determined following Salaudeen *et al*. and Michel *et al*. (2008). Data analysis was done using Cropstat Windows Version 7.2 (IRRI, 2007), and significant differences between means were determined using Fishers Least Significant Difference Test at 1 and 5 % probability levels.

Results and Discussion

The result of serological analysis using TAS-ELISA, and the characterization of the six RYMV isolates indicated that four isolates from Obubu-Ofu (Kogi State), Wuya (Niger State), Makurdi (Benue State) and Mararaba-Obi (Nasarawa State), belonged to Ser1, while isolates from Edozhigi (Niger State) and Gulu (Niger State) belonged to Ser2 (Table 1). The identification of Ser1 and Ser2 in the four north-central states is in agreement with earlier reports that these serotypes are common in West African Countries (Fargette *et al*., 2002; Kanyeka *et al*., 2007). The result of Table 2 showed that disease severity increased progressively on the susceptible rice genotype (Bouake 189) from 14 Days after inoculation (DAI); whereas the *O. indica* cv Gigante infection trend indicated a slow disease development at early infection stage, which peaked at 42 DAI (Table 2). The breakdown of resistance among resistant genotypes was observed in early infection stage as hypersensitive reaction and later (≥ 42 DAI), as either clear mottle symptoms (Gigante) or symptom of localized infection (Tog 5681 and Tog 5672) at 42 DAI. The report of symptom expression on Gigante by Makurdi and Obubu-Ofu isolates in the present study, and virus disease severity (%) of 6.22 – 7.43% based on SES score at 42 DAI recorded on Tog 5681 and Tog 5672 with Gulu and Mararaba-Obi isolates are also indications of virus pathogenicity, and ability of virus strains reacting differently on different cultivars. Ochola and Tusiime (2011) had reported no significant differences in aggressiveness between islolates of RYMV in eastern Uganda. The expression of yellow mottle symptom on the resistant Gigante subspecies in the present study shows that the resistant alleles - rymv1-1 and rymv1-2, were circumvented by the six virus isolates; whereas rymv1-4/rymv2 (Tog5672) and rymv1-3 only broke down with Mararaba-Obi and Gulu isolates at 42 DAI respectively. Rymv1-5 found in Tog 5674 was not affected by the six virus isolates, but sap extract from the plant elicited characteristic symptoms of RYMV at SES score of 5 on highly susceptible Bouake 189 during back inoculation test (Table 2). Plant yield (g) at harvest was significantly low on the susceptible genotype (Bouake 189), which produced zero yield with Gulu, Makurdi and Edozhigi isolates. Plant yield (g) also varied significantly (P = 0.01) across the levels of virus isolates inoculation on Tog 5674, Tog 5672 and Tog 5681 at harvest (Figure 1). The result also indicated yield losses (%) at harvest (up to 100%)

in the highly susceptible Bouake 189 due to virus inoculation with Gulu, Makurdi and Edozhigi isolates. Moreover, virus isolates from Makurdi and Obubu-Ofu, belonging to S1 strains reacted differently and circumvented the resistance in Gigante, producing obvious mottling symptoms of RYMV in an artificial condition.

Conclusion

The present study has reported significant differences in the aggressiveness of isolates of RYMV isolates existing in north-central Nigeria, and confirmed the resistance breakdown in the conventional resistant Gigante subspecies. Rymv1-5 found in Tog 5674 was not affected by the six virus isolates, but sap extract from the plant elicited characteristic symptoms of RYMV at SES score of 5 on highly susceptible Bouake 189 during back inoculation test.

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Table 1: Serological analysis and characterization of RYMV isolates collected from six locations of Mararaba-Obi, Gulu, Makurdi, Wuya, Edozhigi and Obubu-Ofu

RYMV Isolate	**OD (405nm, 3hrs) using Monoclonal antibodies (Mabs)**			
	Mabs A	**Mabs G**	**Mabs D**	**Serological group**
Mararaba-Obi	0.807^{+}	3.232^{+}	0.553^{-}	S1
Gulu	0.374^{-}	3.169^{+}	0.474^{-}	S2
Makurdi	0.605^{+}	3.210^{+}	0.458^{-}	S1
Wuya	0.744^{+}	3.196^{+}	0.475^{-}	S1
Edozhigi	0.566^{-}	3.213^{+}	0.469^{-}	S2
Obubu-Ofu	0.758^{+}	3.222^{+}	0.481^{-}	S1

OD ≤ 0.31 ≤ 0.6 = 1 (negative); OD ≤0.61≤1.2 = 2 (positive); OD ≤ 1.21 ≤ 1.8 = 3 (positive); OD ≤ 1.81 = 4 (positive).

If, Mabs A (+ve) and Mab D (-ve) = S1, Mab A (+ve) and Mab G (+ve) = S1, Mabs A (-ve) and Mabs D (+ve) = S2, Mab A (-ve) and Mabs G (+ve) = S2

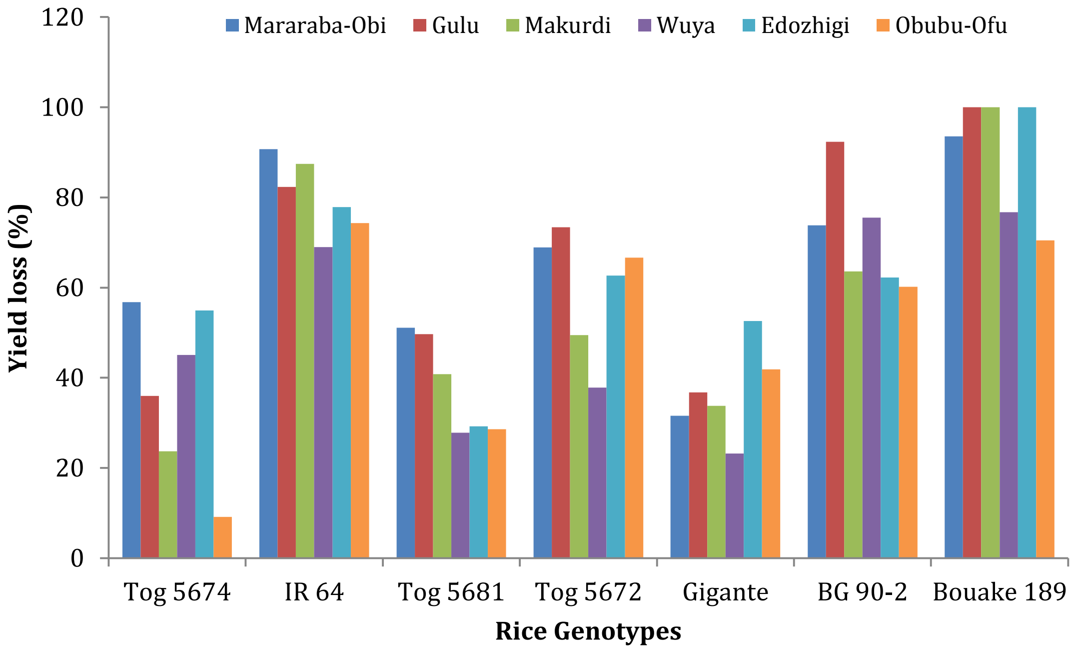

Figure 1: The contribution of RYMV isolates to yield losses (%) on the test rice genotypes in the screen house condition

Table 2: The virus disease reactions and severity on the rice genotypes based on standard evaluation scale (SES) score and back inoculation test (BIT)

Disease Isolates	Rice Genotypes	Disease assessment at 14 DAI		Disease assessment at 42 DAI		BIT
		SES score	Disease severity (%)	SES score	Disease severity (%)	
Mararaba-Obi	Tog 5674	1	0.00	1	0.00	+++
	IR 64	7	5.68	7	8.33	+++
	Tog 5681	1	0.00	1	0.00	+++
	Tog 5672	1	0.00	3	6.36	+++
	Gigante	1	0.00	3	2.65	+++
	BG 90-2	7	5.29	9	10.40	+++
	Bouake 189	7	4.81	9	11.11	+++
Gulu	Tog 5674	1	0.00	1	0.00	+++
	IR 64	7	7.08	5	8.72	+++
	Tog 5681	1	0.00	3	6.22	+++
	Tog 5672	1	0.00	3	7.43	+++
	Gigante	1	0.00	3	4.72	+++
	BG 90-2	7	6.35	7	8.77	+++
	Bouake 189	7	6.85	9	10.49	+++
Makurdi	Tog 5674	1	0.00	1	0.00	+++
	IR 64	7	6.35	9	8.74	+++
	Tog 5681	1	0.00	1	0.00	+++
	Tog 5672	1	0.00	1	0.00	+++
	Gigante	1	0.00	7	7.41	+++
	BG 90-2	9	10.19	9	40.74	+++
	Bouake 189	9	8.27	9	10.58	+++
Wuyya	Tog 5674	1	0.00	1	0.00	+++
	IR 64	7	6.49	7	6.92	+++
	Tog 5681	1	0.00	1	0.00	+++
	Tog 5672	1	0.00	1	0.00	+++
	Gigante	1	0.00	3	4.22	+++
	BG 90-2	7	7.10	7	8.13	+++
	Bouake 189	7	8.06	9	10.70	+++
Edozhigi	Tog 5674	1	0.00	1	0.00	+++
	IR 64	7	7.65	5	7.66	+++
	Tog 5681	1	0.00	1	0.00	+++
	Tog 5672	1	0.00	1	0.00	+++
	Gigante	1	0.00	1	0.00	+++
	BG 90-2	5	6.30	9	10.65	+++
	Bouake 189	5	7.58	7	7.42	+++
Obubu-Ofu	Tog 5674	1	0.00	1	0.00	+++
	IR 64	3	5.85	5	6.28	+++
	Tog 5681	1	0.00	1	0.00	+++
	Tog 5672	1	0.00	1	0.00	+++
	Gigante	1	0.00	5	6.44	+++
	BG 90-2	5	6.68	7	8.49	+++
	Bouake 189	7	7.21	7	8.10	+++
Control	Tog 5674	-	0.00	-	0.00	-
	IR 64	-	0.00	-	0.00	-
	Tog 5681	-	0.00	-	0.00	-
	Tog 5672	-	0.00	-	0.00	-
	Gigante	-	0.00	-	0.00	-
	BG 90-2	-	0.00	-	0.00	-
	Bouake 189	-	0.00	-	0.00	-
	SE, Virus Isolates (VI):		0.160**		1.572*	
	SE, Rice Genotypes (RG):		0.168**		1.615**	
	SE(VI x RG):		0.444**		4.271NS	

SES: Standard Evaluation scale for rice at 5 weeks after inoculation (IRRI, 1996); where, 1 - 3 = R (resistant), 5 = MR (moderately resistant), 7 = MS (moderately susceptible), and 9 = HS (highly susceptible); * = Significant (P = 0.05); ** = highly significant (P = 0.01); NS = Non-significant

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Plant Tissue Analysis of Maize (Zea mays l.) in Tropical Ultisol of South-Western Nigeria

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Abstract

Plant tissue analysis of Zea mays was conducted at Yaba College of Technology, Epe Campus (Southwestern Nigeria) during 2017 cropping season. The experiment was a Randomized Complete Block Design(RCBD) with 4 replicates covering different locations of the campus. The maize crop was evaluated for its proximately and mineral composition after maturity. Data obtained were analyzed using Analysis of variance (ANOVA) and treatment means were separated using Duncan multiple range test(DMRT). Result indicated increased values for macro nutrients such as potassium (150-125%), sodium (40-28%), calcium (32-25%), and magnesium(8-6%) as well as micronutrient such as zinc (21-19%), while micronutrients including iron (4-3%), copper (1.3-8.84%) and manganese (0.13-0.05%) were significantly low. Proximate composition revealed that carbohydrates has the highest component (46.63%). Followed by ash (22.06%), protein (17.26%), moisture content (10.34%), and crude fibre(6.15%), while the lowest component was fat (4.95%). Thus, effort aimed at obtaining high yield of maize would necessitate the augmentation of nutrient status of the soil particularly micronutrients to meet the crop requirement for optimum productivity and maintaining soil fertility with the use of organic or inorganic materials.
Keywords: Plant tissue analysis, Zea mays, Proximate and mineral composition

Introduction

In Nigeria, maize (*Zea mays*) is a major cereal crop for human nutrition, livestock feed and raw materials for industries. It is primarily an energy giving food because of its high starch content. It is grown either as mono or mixed crop in the backyard garden, as a field or plantation crop. It is Nigeria's third most important cereal crop after sorghum and millet (FAO, 1996). Maize is an important cereal crop due to its high yielding, ease of processing, readily digested and cost less than other cereals (Jaliya et. al. 2008) and therefore, it will continue to play a large and important role in Nigeria food production. Nweke and Nsoanya (2013) observed that, maize cultivation has immense potential in the tropics and yield of 7.5 tonnes per hectare can be obtained if the crop is properly managed. Unfortunately, yield are still below 5 tonnes per hectare (FAO, 2007) and this has caused inadequacy of maize production. One of the major problems associated with maize in tropical ecology is poor soil fertility. This is due to intensive cropping system, which has now become a characteristicfeatures of Nigeria arable agriculture. This practice depleted the soil nutrient over short period of time as a result of continuous cropping on a particular land. Maize is an exhaustive crop and has a very high nutrient requirement (Nweke and Nsoanya, 2013). It fails to provide good grain in plots without adequate nutrients (Adediran and Banjoko, 2003) and therefore productivity depends on nutrients management. The removal of nutrients from the soil by crop harvest has to be balanced by the addition of manure (Ofusu-Amin et. al. 2006). One of the method by which nutrient status of the soil can be determined for soil nutrient management is by plant tissue analysis. It is used to confirm suspected nutrient deficiencies after visual symptoms has been observed and uncover potential problems. It is complimentary to soil testing and thus reference concentration of mineral nutrients in a specific part are established and used to the well-being of the plant and effectiveness of the soil fertility programme (Uponi and Adeoye, 2000).*Zea mays* is used in this study (plant tissue analysis) due to its nutritional and industrial potential in Nigeria. However, Omofunmi*et al*, (2017) carried out assessment of land suitability for crop production and irrigation in the study area. This present work therefore corroborates the effort of Omofunmi*et al*, (2017). The information provided would help to correct nutrient problems and monitor the effectiveness of soil fertilityprogramme and ascertain the nutrient status of the soil in the study area.

Materials and Methods

Field work: The experiment was carried out at Yaba College of Technology (YABATECH), Epe Campus at 4 different locations (North, South, East and West of the campus) in March and May, 2017. The Polytechnic is located at km 16 along Epe-Ijebu Ode road, Odoragushin in Epe Local Government Area of Lagos State (06^{o} 47^{o}N and 03^{o} 58^{o}E). Epe lies in lowland rain forest vegetation with bimodal rainfall pattern between April and October while dry season is between November and March. The plot size was 3 meters by 4 meters(12meter square). The soils were tilled after marking out the site into plots. The maize seeds (TMRS6) used were improved variety obtained from Lagos state Agricultural Input Supply Company, Epe depot. They were planted at two seeds per hole at a depth of 2 centimeters deep spaced at 75 centimeter by 25 centimeter and were laid out in a randomize complete block design with four replications. Cultural operations such as watering (in the morning and evening prior to rainfall) and manual weeding at 4 and 8 weeks after planting) were carried out to ensure good growth of maize. Harvesting was done manually at 12 weeks after planting.

Laboratory work (Proximate and mineral analysis of sampled *Zea mays*): 5 plants from each plots were randomly selected from the harvested *Zea mays* for laboratory analysis. The roots were carefully washed with running water, air dried, grinded manually with porcelain mortar and pestle and milled to pass through 0.5mm sieve, stored in plastic bottles and labeled appropriately and thereafter analyzed in triplicate for its proximate analysis following the method of Association of Analytical Chemist (2012). For moisture (using auto moisture analyzer model ML-50), ash (using carbolite model), protein (kjeldahl digestion and steam distillation method with model KJELTEC 8200), fibre (using FIBRETEC hot/hydrolysis unit, model 1020) and fat (using Soxtec Extraction System, Soxtec model 2005). Protein content was obtained by multiplying the Nitrogen value by a factor of 6.25 (kjeldahl Nitrogen) while available carbohydrate (Nitrogen Free Extract) was calculated using differentiation method. To determine the mineral composition of *Zea mays,* the mineral content was determined by digestion and wet oxidation methods (Association of Analytical Chemist, 2012) using $HCLO_3/HNO_3/H_2SO_4$ mixture. Sodium and Potassium was assayed by flame photometry (Model AAS 200A, Busch Scientific). Calcium and Magnesium was determined by Atomic Absorption Spectrophotometry (AAS) while Phosphorus was determined by Colorimetric Spectrophotometer using Vanadomolybdate reagent. Nitrogen in the digestion was evaluated using auto analyzer.

Data analysis

Data were subjected to analysis of variance with SAS Software (2001). Significant means separated using Duncan Multiple Range Test (DMRT) statistics.

Results and Discussion

Table 1 summarizes the result of proximate composition of the maize seeds.

Carbohydrate*:Zea mays* have higher proximate value for carbohydrate (46.63%) followed by ash(22.06%),protein(17.26%),moisture(10.34%),crude fibre (6.15%) and fat(4.95%).Carbohydrates are the major chemical component of the maize grain. This notion is in agreement with Ijabadeniyi and Adebolu(2005). which reported 65.63-70.23% of the carbohydrate content for the maize varieties grown in Nigeria.Ikram et.al (2010)also reported higher carbohydrate content(69.65-74.54%)for maize in Pakistan.

Ash: It can be defined as the quantity of mineral matter which after application remains as incombustible residue of the tested substances (Ikram, 2010).The second largest chemical component of the kernel is ash(22.06-18.70%).Percentage content of different maize varieties were found in the range of 1.3 and 1.20% by Ikram(2010)which is lower than the present study.Thus,the grain with high ash (as in this study) contained a greater proportion of non-endosperm material (Ikram, 2010).Hence,Evers (2011) opined that ash values are determined in order to indicate the level to which non-endosperm components are present.

%Protein: Percentage protein were in the range of 17.26 and 13.84% and is the third largest chemical present in the maize grains after carbohydrate and ash.Ijabadeniyi and Adebolu(2005)found the percentage of protein content of three maize varieties in the range of 10.67-11.27% which were lower than the result of the present study. According to

Ikramet.al(2010),maize kernel contains albumin,globulin,prolamins and glutelins with two types of storage protein predominant in the seed, the embryo contains globulin and the endosperm(the major site of storage protein accumulation)contains predominantly prolamins,the so called zein fraction.

%Moisture content: Values for seed moisture content were determined in the range of 10.34-8.78% and was the fourth largest chemical found in kernel.Ikram et.al(2010)found the moisture value between 10.98 and 9.20%,which is in close agreement with this present study.

% Crude fibre: This was the fifth largest chemical component found in the range of 6.15-4.80%.Ijabadeniyi and Adebolu(2005) showed percentage crude fibre of maize varieties grown in Nigeria between 2.07-2.77% and that of Ikram et.al(2010) between 0.80-2.32% in Pakistan which are lower values compared with result of the present study.

%Fat: The level of fat were found between 4.95 and 3.87% which is in close consistent withthe Ijabadeniyi and Adebolu(2005) which reported percentage fat between 4.77 to 5.77% for the grains.

Table 1: Proximate composition (mg/100g) of *Zeamays* harvested from experimental plots at YABATECH

Sample	Moisture	Ash	Fat	Protein	Crude Fibre	Carbohydrate
A (North Location)	10.34±0.08^{a}	20.16±0.03^{b}	3.87±0.01^{c}	13.84±0.06^{b}	6.15±0.07^{a}	45.65±0.12^{a}
B (South Location)	9.30±0.08^{b}	18.70±0.03^{d}	4.24±0.06^{a}	15.64±0.06^{c}	5.50±0.14^{c}	46.63±0.25^{a}
C (East Location)	9.62±0.06^{c}	19.25±0.01^{a}	4.48±0.03^{d}	17.26±0.10^{d}	4.45±0.07^{b}	44.95±0.19^{a}
D (West Location)	8.78±0.06^{d}	22.06±0.00^{c}	4.95±0.04^{d}	14.91±0.04^{a}	4.80±014^{b}	44.50±0.00^{a}

Values represent the Mean ± SEM. The value with the different letters in a column are significantly different from one another @ ($p<0.05$) according to DMRT

The mineral composition of the plant tissue analysis of the maize is shown on table 2.Presence of minerals in hierarchical order are K(between 150-125%),Na(between 40-28%),Ca(between 32-25%),Zn(between 21-19%),Mg(between 8-6%),Fe(between 4-3%),Cu(between 1.3-0.84%) and Mn (0.13-0.05%).Thus, the concentration of potassium was the highest while Manganese was the lowest.This confirmed the result of Omofunmi*et al,* (2017) which revealed that macro-nutrients such as K,Ca,Na,Mg are adequate while micro-nutrients such as Fe,Cu and Mn are also present but significantly low in the soil of Yaba College of Technology,Epe Campus.Thus,effort aimed at obtaining high yield of maize would necessitate the augmentation of nutrient status of the soil to meet the crops requirement for optimum productivity and maintaining soil fertility. Increasing the nutrients status of the soil may be achieved by boosting the soil nutrient content with the use of inorganic fertilizer or the use of organic materials.(Agba et.al.2012).The maize requires an adequate supply of nutrients particularly N.P.K for optimum growth and yield. The most important micro-nutrients particularly in the savannah zone and under continuous cropping in the forest ecology are Sulphur,Zinc and Magnesium (Iken and Amusa,2004).

Table 2: Minerals composition of *Zea mays*harvested from experimental plots at Yaba College of Technology, Epe Campus

Sample	Mg	Ca	Na	K	Fe	Mn	Cu	Zn
A (North Location)	8.77±0.21^{a}	28.80±1.07^{b}	32.85±0.35^{a}	150.52±0.18^{b}	4.59±0.05^{d}	0.13±0.01^{a}	1.33±0.04^{b}	19.12±90^{c}
B (South Location)	8.12±0.08^{a}	25.44±0.30^{c}	40.33±0.35^{b}	135.16±0.23^{a}	4.08±0.05^{c}	0.08±0.01^{b}	1.04±0.04^{c}	15.19±0.72^{b}
C (East Location)	6.96±0.12^{b}	32.72±0.46^{d}	28.52±0.35^{c}	125.72±0.23^{d}	3.78±0.05^{b}	0.05±0.00^{c}	1.16±0.06^{d}	21.27±0.71^{c}
D (West Location)	6.21±0.011^{d}	26.74±0.31^{a}	35.64±0.29^{d}	140.75±0.18^{c}	3.42±0.05^{a}	0.09±0.01^{b}	0.84±0.04^{a}	16.97±0.36^{d}

Values represent the Mean ± SEM. The values with the different letters in a column are significantly different from one another ($P<0.05$).According to (DMRT).

Conclusion

Finding in this study have shown the proximate composition of *Zea mays*has havingcarbohydrate asthe highest value while fat is significantly low compared to other nutrients.The study also shown that the mineral content of the soil are higher in K,Na, Ca,Zn and lower in Mg, Fe, Cu and Mn. Therefore, this result will be useful in providing information about the nutritional properties of the soils of Yaba College of Technology,Epe Campus and may guide us in designing strategies that maximize the utility and production of different crops. It is therefore, recommended that the result of soil survey and analysis by Ibrahim et.al.(2013) and the result of this study (Plant tissue analysis) be strictly adhered to and areas that needs to be augmented by fertilizing and manuring should be done, because fertilizer add nutrient to the soil which are lacking in it and adopting a good fertilizer programme is a major way of improving yield in crops, and as such the optimum dose that gives the highest earning on the investment must be used.

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Influence of crop establishment methods and weeding regimes on yield and yield components of hungry rice (*Digitaria exilis* Kippis Stapf) at Badeggi, Niger State

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Abstract
An experiment on the influence of crop establishment methods and weeding regimes on the yield and yield components of hungry rice (D. exilis) was carried out during the cropping season of 2016 and 2017 at the research field of the National Cereals Research Institute, Badeggi (Lat. 9^o 45^1 N and Long 6^o 97^1 E). The treatments consisted of two crop establishment methods (broadcasting and drilling at 30cm inter-row spacing and four weeding regimes (weeding once (w_1), weeding twice (W_2), weeding thrice (W_3) and a weedy check (w_o). A split-plot design was used such that crop establishment methods were allocated to the main plots and weeding regimes were assigned to the sub-plots. The experiment was replicated four times. The land was prepared manually but ensured to be leveled properly. The plot size was 3.0m x 4.0m leaving a distance of 1.0m between replications and 0.5m between plots as alleyways. Hungry rice (Vakahal (Local) accession was used. Fertilizer (NPK 15:15:15) was used to supply 30kg N ha^{-1}, 30kg $P_2O_5gha^{-1}$ and 30kg K_20 ha^{-1} basal. Weed management was by manual hand pulling of weeds 4 weeks after sowing (WAS). Data taken include number of tillers, plant height, length of spikes and grain yield respectively. Results showed that drilling method of sowing produced more tillers, taller plants and higher grain yield in both years compared to broadcasting method. While crop establishment methods had no significant influence on length of spikes in both years of experimentation. Among the weeding regime treatments, weeding thrice had significantly higher tillers, plant height and grain yield over the other treatments in both years. From this study, the best method of sowing hungry rice (D. exilis) is by drilling and weeding thrice.
Key words: Digitaria exilis, crop establishment, hungry rice, sowing methods and weeding regime

Introduction
At this time of climate change and its influence on Food Security and Insecurity, many people in the dry environments of Nigeria and Africa will depend on cereals that are grown in drought water stress and marginal environments such as millet, sorghum and finger-millet, among other dry land crops (CGIAR, 2002). The poor rural farmers whose major occupation is still farming require crops of low input demand and can also give appreciable and stable yields on their poor environments. Hungry rice (*D. exilis*) is an important candidate crop for food security in West Africa and is assuming greater importance in the context of changing climate and increasing demand or highly nutritious food with low cost of input (Animasaun *et al.,* (2014). Hungry rice (*D. exilis*) has high potentials for fighting hunger in the Sub-Saharan Africa (Vietmeyer *et al.,* 1996). The crop is grown as human food and as forage (Aliero and Murakinyo, 2001) in the Savanna Zones of West Africa and also as a staple. The crop is traditional, well adopted to local conditions and possesses good nutritional culinary properties (Cruz, 2004). The tiny grain of hungry rice (D. exilis) can be used to make tuwo, couscous, porridge, malt drinks, in pharmaceutical industries as a binder in the production of Paracetamol (Musa *et al.,* 2008), good for human health, recommended for people with diet challenges. It is reported that dishes of hungry rice (*D. exilis*) show higher preference than those of rice, millet maize, among growers (Cruz, 2004). The production of hungry rice (*D. exilis*) in Nigeria and elsewhere is faced with a number of problems such as weed control, seeding rate, establishment methods, small seed size,

low yield and its post-harvest transformation (Ukwungwu *et al., 2003*; Dachi, 2014). Hungry rice (*D. exilis*) has the potential of producing higher grain yield with good agronomic practices such as appropriate establishment method, seed rate and proper weed control. Few studies have been conducted as regards appropriate establishment method and weeding regime in hungry rice (*D. exilis*). The objective of this study was to obtain the best establishment method and weeding regime for growth yield and yield components of hungry rice (*D. exilis*).

Materials and Methods

The experiment was conducted at the National Cereals Research Institute, Badeggi (Lat. 9^0 45^1 N and Lon. 6^0 07 E) during 2016 and 2017 cropping season. The soil of the site was sandy loam. The treatments consisted of two crop establishment methods (broadcasting and drilling at 30cm inter-row spacing) and four weeding regimes (weeding once (W_1), weeding twice (W_2), weeding thrice (W_3) and a weedy check (w_o). The experimental design was a split-plot with four replications. Establishment methods were allocated to the main plots and weeding regimes to the sub-plot. Plot size was 3.0m x 4.0m. Hungry rice (D. exilis) Vakahal accession (local) was sown by broadcasting and drilling into each of the plots. Weed weeding regime was carried out according to treatments by manual hand pulling of weeds. Basal fertilizer application of 30kg N ha^{-1}, 30kg $P_20_5ha^{-1}$ and 30kg K_20ha^{-1} using NPK 15:15:15 fertilizer, source. Data were taken on number of tillers, plant height, leaf area, length of spikes and grain yield. The data were subjected to analysis of variance and treatment effects were compared using least significant difference at 0.5 percent level of probability.

Results and Discussion

The influences of crop establishment methods and weeding regimes had significant effects on number of tillers and plant height in both years of studies. Significantly higher number of tillers, and plant height were produced in drilling method of sowing and weed free (w_3) than broadcasting method and no weeding (w_o). The increase in these parameters recorded in drilling method of sowing and weed free (w_3) conditions than in broadcasting method and no weeding conditions (w_o) could be attributed to better micro environment in the drilling method of sowing and weed free conditions compared to those in broadcasting method and no weeding (w_o) conditions. Also, the better crop stand establishment in drilling method of sowing and weed free (w_o) conditions might have been responsible for the increase in number of tillers and plant height due to less competition for growth factors (Tables 1 and 2). This finding is in line with Dachi (2014) and Mondal *et al*., (2013) who reported similar results in drilling method of sowing than in broadcasting in acha (*D. exilis*) and weed free (w_o) in Aus rice respectively. In both years, crop establishment methods had no significant influence on length of spikes. This might be due to genetic factor of the crop (Table 3). Crop establishment methods and weeding regimes had significant influence on grain yield in both years. The highest grain yields were found in drilling method of sowing and weed free (W_3), followed by weeding twice (W_2) in both years and the lowest grain yields were recorded from broadcasting method of sowing and no weeding (W_0) condition (Table 4). This could be attributed to the fact that in drilling method of sowing and weed free (W_3) conditions, plants got higher nutrients, light, water and less competition from weeds which resulted in higher grain yields. The obtained result is in close agreement with Dachi (2014) and Mondel *et al*, (2013) who reported highest grain yields in drilling method of sowing in acha (D. exilis) and weed free (W_3) condition in AUS rice respectively (Table 4).

Conclusion

From the result of this study, it is conclusion is that drilling method of sowing and weeding thrice are best for acha (D. exilis) production at Badeggi, Nigeria.

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Table 1: Influence of crop establishment methods and weeding regimes on number of tillers per plant.

Crop establishment methods	2016	2017
Broadcasting	10.95	20.32
Drilling	13.03	22.26
LSD(0.05)	1.64	1.63
Weeding regimes		
w_0	18.85	8.83
w_1	22.87	10.47
w_2	25.17	12.63
w_3	28.27	14.03
Lsd(0.05)	2.31	2.22
Interaction	Ns	Ns
Cv (%)	17.8	8.4

Wo = No weeding, W1 = Weeding once, W2 = Weeding twice, W3 Weeding thrice

Table 2: Influence of crop establishment methods and weeding regimes on plant height (cm)

Crop establishment methods	2016	2017
Broadcasting	67.72	81.67
Drilling	79.16	89.28
Lsd (0.05)	5.16	3.13
Weeding regimes		
W_0	70.89	43.77
W_1	78.00	51.98
W_2	83.00	60.70
W_3	86.99	71.31
Lsd(0.05)	4.42	7.29
Interaction	ns	ns
Cv (%)	9.1	4.4

W_0 = No weeding, W_1 = Weeding once, W_2 = Weeding twice, W_3 = Weeding thrice

Table 3: Influence of crop establishment methods and weeding regimes on number of spikes per plant

Crop establishment methods	2016	2017
Broadcasting	11.47	12.65
Drilling	11.68	12.61
Lsd (0.05)	ns	ns
Weeding regimes		
W_o	12.19	11.49
W_1	12.66	11.73
W_2	12.76	11.62
W_3	12.92	12.05
Lsd(0.05)	ns	ns
Interaction	ns	ns
Cv (%)	4.3	4.7

W_o = No weeding, W_1 = Weeding once, W_2 = Weeding twice, W_3 = Weeding thrice

Table 4: Influence of crop establishment methods and weeding regimes on grain yield (kg ha^{-1})

Crop establishment methods	2016	2017
Broadcasting	468.75	348.65
Drilling	611.67	487.92
Lsd (0.05)	133.12	91.82
Weeding regimes		
W_o	255.00	187.50
W_1	358.33	327.78
W_2	399.17	436.95
W_3	560.83	666.61
Lsd(0.05)	129.86	188.26
Interaction	ns	ns
Cv (%)	29.2	28.5

W_o = No weeding, W_1 = Weeding once, W_2 = Weeding twice, W_3 = Weeding thrice

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Effect of Garden Egg Population on Growth and Yield of Component Crops in Sweetpotato/ Garden Egg Intercropping System in South Eastern Nigeria

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Abstract
The experiment was conducted at Umudike (latitude 05° 29' N, longitude 07°33' E) in 2014 to determine the effects of garden egg (Solanum gilo) population on growth and yield of sweetpotato /eggplant intercrop. Four populations of eggplant 10,000, 20,000, 30,000 and 40,000 plants/ha were intercropped with two varieties of sweetpotato (Umuspo 1 and TIS 87/0087), and sweetpotato planted at spacing of 1m x 0.30m in randomized complete block design. Data on plant height, leaf number, and branch number for garden egg; and vine length, leaf number and branch number for sweetpotato were taken at 8 and 10 WAP. Sweetpotato roots yield was assessed at 16 WAP. The yield of garden egg fruits was sum from 60 to 90 DAP. The results showed that intercropping significantly reduced growth and yield attributes of both plants as the population increases from 10000 plants/ha to 40000 plants/ha. The yields of sole crops were higher than individual crops in the intercrop. Garden egg at 10,000 plants/ha + sweetpotato at 33,333 plants were significantly better than other populations. Land equivalent ratio of intercrops were above unity, and gross monetary returns were higher in intercropping than sole implying that there were higher productivity in intercropping which means that farmers can make more income by intercropping.

Introduction
Intercropping is an agricultural practice of growing two or more crops simultaneously on the same field during a growing season in definite pattern or arrangements (Francis, 1989, Filho, 2000). It is a scientific application of mixed cropping in terms of crop spacing, time of planting and quantity and quality of fertilizer application (Muoneke, 2017). Sweetpotato, *Ipomoea batatas* (L.) Lam) is one of the world's most widely grown and variable crops, and farmers in more than 100 countries rely on its ability to produce high yield in marginal soil with little investment (Horton *et al*, 1989). It is used for poverty alleviation and food security due to its high productivity per unit land area and time which makes it a crop for the survival of resource poor farmers in Nigeria. Garden egg *Solanum gilo* (L.) is a small-size dessert fruit type, fruit vegetable that belongs to the Solanaceae family of flowering plants. It is also an important crop grown in Nigeria for both its leaves and fruits which has cultural, social and economic importance. Both sweetpotato and garden egg feature prominently in the cropping systems in many agricultural zones of Nigeria. They may be grown as monocrops or intercrops but mixed cropping or intercropping is the predominant cropping system (Ekwere *et al*., 2009).
Optimum plant population ensures crop growth, development and yield. Maximum productivity in intercropping could be obtained when inter and intra specific crop competition are minimal for growth limiting factors and the density of each crop adjusted to minimize competition (Okpara *et al*., 2004). Over population results in excessive plant competition for production factors which could reduce the overall productivity of the crop and under populations reduce potential crop yield per unit area (Hector, 2010). Generally, high yields per unit area are obtained from high populations because of maximum use of light, although the performances of the individual plants decrease. Therefore the objective of study was to determine the effect of garden egg (GE) population on growth and yield of component crops in sweetpotato/garden egg intercropping system.

Materials and Methods

The field experiment was carried out at the National Root Crops Research Institute, (NRCRI), Umudike experimental field during the 2014 cropping season. Umudike is located on longitude 07˚ 33 E and latitude 05˚ 29 N and at an elevation of 122 m above sea level in the rainforest agro-ecological zone of Nigeria. The experimental field was cleared, ploughed, harrowed and ridged in May. The experiment was laid out in factorial arrangement using randomized complete block design (RCBD) and replicated three times. The plant population for the two sweetpotato varieties (TIS 087/0087 and Umuspo 1) were 33,333 plants/hectare while the populations for garden egg were 10,000, 20,000, 30,000 and 40,000 plants/ha. Data were collected on vine length, number of leaves and branches for sweetpotato while for garden egg height, number of leaves and branches at 8 WAP and 10 WAP. Sweetpotato roots yield was assessed at 16 WAP. The yield of garden egg fruits was sum from 60 to 90 DAP. Data collected from the crops in the field experiment were subjected to analysis of variance according Genstat Discovery Edition 1 and means compared using Fisher's least significance difference (LSD) at 5% level of probability.

Results and Discussion

The results showed that intercropping significantly reduced sweetpotato vine length, number of leaves and number of branches. Vines were longer in sole than intercropping at 8 WAP and 10 WAP (weeks after planting). TIS 087/0087 vines were longer than Umuspo 1 while Umuspo 1 had higher of leaves than TIS 87/0087. Sweetpotato varieties did affected plant vine length, number of leaves and number of branches of sweetpotato. Garden egg height, number of leaves and number of branches were reduced by cropping system. Increase in garden egg population significantly decreased vine length, number of leaves and number of branches (Tables 1 and 2). Garden egg population reduced plant height, number of leaves and number of branches at 8 WAP and 10 WAP as the population increased from 10,000 plants/ha to 40,000 plants/ha. There was no interaction between the cropping system X sweetpotato varieties and sweetpotato X garden egg population. The yields of sole crops were higher than individual crops in the intercrop; this finding is in agreement with the report of (Arubalueze, 2016) on cassava and cowpea intercrop. Cropping system significantly reduced weight of root/plant and root weight/ha which agreed with (Njoku *et al.*, 2010). Garden egg at 10,000 and sweetpotato populations at 33,333 plants/ha were better than other populations. In crop mixtures plant population should be adjusted to avoid over crowding. Abolhassan, (2005) reported that high plant density results in excessive plant competition for production factors which could reduce the overall productivity of the crop. In higher population, low fruit yield of garden egg were obtained, which could be as a result of higher intra specific competition for growth resources like light, water, soil nutrient by high population (Amih, 2013). Land equivalent ratio of intercrops were above unity, and gross monetary returns were higher in intercropping than sole implying that there were higher productivity in intercropping. Farmers can make more income by intercropping. The higher productivity per unit area due to intercropping over sole in all the populations confirmed the works of Muoneke and Mbah, 2007 and Ekwere *et al*., 2009). For maximum productivity, planting sweetpotato at 33,333 + garden egg at10,000 plants/ha should be practiced by farmers.

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Table 1: Effect of cropping system and population on growth and yield of sweetpotato varieties in 2014

Attributes	**Vine length(cm)**		**No. of leaves**		**No. of branches**		**Root yield (t/ha**	
WAP	**8**	**10**	**8**	**10**	**8**	**10**	**Wt./ plant**	**Total root (g)**
Cropping system								
Sole	202.1	258.38	85.58	128.08	6.38	9.04	633	21.09
Intercrop	163.5	208.26	76.52	125.51	4.91	6.84	487	16.14
LSD(0.05)	22.11	11.11	2.90	NS	0.66	1.06	107	3.76
Garden egg population								
10, 000	197.3	236.19	85.27	138.55	6.29	8.69	621	20.74
20,000	181.4	224.15	77.44	127.85	5.17	7.19	574	19.01
30,000	165	213.81	76.77	126.93	4.84	7.33	465	15.34
40,000	141.9	194.98	73.85	110.97	4.50	5.90	405	13.44
LSD(0.05)	20.84	5.54	4.80	6.82	0.66	0.88	117	4.07
Sweetpotato varieties								
Umuspo 1	90.4	113.15	87.25	133.85	6.02	8.63	618	20.53
TIS 87/0087	252	321.42	69.42	118.47	4.34	5.93	415	13.73
LSD(0.05)	16.38	4.20	3.39	1.02	0.78	0.21	110	3.62
Cropping system x sweetpotato varieties								
LSD(0.05)	NS	5.55	NS	0.89	0.61	NS	872	NS
Sweetpotato varieties x G.E								
LSD(0.05)	13.91	7.52	NS	NS	NS	NS	NS	NS

Table 2: Effect of cropping system and population on growth and yield of garden egg in 2014

Attributes	Plant height (cm)		No. of leaves		No. of branches		Fruit yield(t/ha)	
WAP	**8**	**10**	**8**	**10**	**8**	**10**	**Wt./plant**	**Total fruit wt**
Cropping system								
Sole	52.24	56.8	18.58	39.5	4.69	5.62	37.7	6.17
Intercrop	49.6	53.9	18.01	32.1	4.20	4.96	26.7	5.01
LSD(0.05)	NS	NS	NS	6.71	NS	NS	NS	0.93
Garden egg population								
10, 000	62.18	68.07	22.69	45.11	6.36	7.76	70.1	6.97
20,000	51.83	56.33	19.94	38.11	5.19	5.67	25.8	5.78
30,000	46.92	59.58	16.33	33.19	3.72	4.08	17.1	5.06
40,000	41.59	44.45	13.83	22.00	2.17	3.06	9.7	3.91
LSD(0.05)	2.63	2.82	1.62	4.55	0.84	0.84	8.27	0.83
Sweetpotato varieties								
Umuspo 1	51.2	55.4	18.50	33.4	4.19	5.00	29.5	5.40
TIS 87/0087	48	52.4	17.52	30.9	2.21	4.92	23.7	4.60
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Cropping system x sweetpotato varieties								
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Sweetpotato varieties x G.E								
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Effect of component population of sweetpotato/ garden egg intercropping on land equivalent ratio (LER) and gross monetary returns in 2014

Cropping systems	Land equivalent ratio (LER)			Gross monetary returns (GMR) (₦)		
	PARTIAL		TOTAL	PARTIAL		TOTAL
Crop	**Sweet potato**	**Garden egg**		**Sweet potato**	**Garden egg**	
Sole Umuspo 1						1,524,000
Sole TIS 87/0087						1,006,200
Sole garden egg 10,000						1,264,500
Sole garden egg 20,000						979,500
Sole garden egg 30,000						798,500
Sole garden egg 40,000						688,500
Umuspo 1+ GE 10,000	0.99	0.83	1.79	1,486,200	1,048,500	2,534,700
Umuspo 1+ GE 20,000	0.86	0.88	1.74	1,308,600	858,000	2,166,600
Umuspo 1+ GE 30,000	0.67	0.94	1.61	1,026,600	750,500	1,776,600
Umuspo 1+ GE 40,000	0.55	0.83	1.39	844,200	574,500	1,418,700
TIS 87/0087+ GE10,000	0.91	0.65	1.55	912,600	822.450	1,735,050
TIS 87/0087+ GE20,000	0.85	0.78	1.63	853,800	762,000	1,6158,800
TIS 87/0087+ GE30,000	0.69	0.91	1.61	696,000	729,000	1,425,000
TIS 87/0087+ GE40,000	0.65	0.72	1.37	649,800	496,500	1,146,300

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Adaptability of Popular *Hevea* Clones and Wild Germplasm to Water Stress in Umudike South Eastern Nigeria

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Abstract
Limiting water availability is one of the major factors that affect the productivity in crop plants. Generally plants manage to survive water deficit to a certain extent either by morphological or physiological modifications that enable them to avoid or postpone desiccation stress. Hevea brasiliensis is a tropical tree crop that is valued for its latex. The latex is referred to as natural rubber. Demand for natural rubber is expected to increase once more with increasing crude oil price and automotive industry in several countries. Ten clones of Para rubber in Nigeria were evaluated for adaptability to water stress. The clones were obtained from Rubber Research Institute of Nigeria Iyanomo, Benin City Edo State and evaluated at the research farm of National Root Crop Research Institute Umudike, Abia State using fresh and dry weight of whole plant and root as indices for adaptability. Among the various growth and productivity limiting factors, the negative impact of drought on root growth has been well established in different Hevea clones.

Introduction
The rubber tree is a native of the Amazonian rainforest of South America. Rubber tree *(Hevea brasiliensis* Muell. Arg.) is the only commercial source of natural rubber and the species is well suited to the equatorial region with plenty of well distributed rainfall of 1800-2000mm per year and minimum fluctuations in temperature (Pires *et al.,* 2002). With increasing global demand for natural rubber, attempts have been made to extend the cultivation of this tree crop to agro-climatically marginal lands such as drought and cold prone areas Nair *et al.* (2010). The crop does not perform well if there is a long dry season. It also does badly if the climate is excessively humid, as this encourages leaf diseases. The rubber tree can tolerate a wide range of soil conditions from sandy to loamy soils provided the soils are deep, fertile, well drained and slightly acidic with a soil p^h of 4-8 or 4-6. The rubber tree is a perennial and deciduous crop with an economics life span of 25-30 years. But the very narrow genetic base of the cultivated *Hevea* resulted from the development of the species from a limited number of seeds introduced by Sir Henry Wickham, limits the scope of extending the clone to such marginal areas. A broad genetic base is a prerequisite for developing new genotypes tolerant to various stress conditions. Plant genetic resources provide the requisite genetic variability and are the most important and vulnerable basic materials to meet the current and future needs of plant breeding programmes Gonçalves *et al.* (2006). The wild germplasm accessions collected by an expedition of International Rubber Research and Development Board (IRRDB) during 1981, into the primary centre of origin of the crop, the Amazon forests provide a rich source of natural variability in this tree species. Introduction of genes from such wild progenitors is an ideal method of broadening the genetic base of cultivated *Hevea* species (Omokhafe and Alika, 2003). The objective of this study was to evaluate *hevea* clones that will adapt to water stress.

Materials and Methods
Hevea genotypes used in this evaluation were sourced from Rubber Research Institute of Nigeria, Iyanomo, Benin City, Edo State. The experiment was conducted at the research farm of the National Root Crops Research Institute (NRCRI), Umudike (latitude 05^0, 29'N; longitude 07^0,

33'E) in 2013 planting season. Umudike is in the tropics and has a total rainfall of about 2177 mm per annum with an average temperature of about 26^{0}C. The predominant vegetation type is rain forest (NEST, 1991), while the soil has been classified as sandy loam ultisol (Agboola, 1979). Climatic conditions during the period of this research work are shown in Table 2. Soil samples were collected at the experimental site using soil auger at a depth of 0-15cm and was analyzed for its physico-chemical properties in the National Root Crops Research Institute Laboratory. The genotypes used were: RRIM 600, NIG 800, NIG 801, NIG 802, NIG 803, NIG 804, PR 107, RRIM 628, GT I, and PB 5/51. Sprouted seedlings were transplanted to the main nursery at one month old on October, 10, 2013 in a randomized complete block design (RCBD) with three replications. Each plot size was 6m^2 (3 x 2m) with 1m apart and contained 30 plants spaced 30cm within and 1m between the rows to give a seedling population of 33,333 seedlings per hectare. The seedlings were watered twice daily (morning and evening) during the dry spell, about three to four manual weeding were done to keep the field weed free. Data on each stand were taken as follows: Weight of whole plant was taken by uprooting the plant at 40 days after exposure to drought stress, taking the fresh weight after uprooting and the dry weight after 7 days of sun drying using sensitive weighing balance (Model 333, manufactured by Acculab Electronic Digital Scale). Weight of root was also taken by cutting off the root of the uprooted plant, washing off the sand, fresh and dry weight were taken at 40 days after subjection to drought stress and at 7 days after sun drying respectively.
Data collected were summarized and subjected to statistical analysis using SAS software (SAS 1998)

Results and Discussion

Soil Physico-chemical Properties of the Experimental sites
The result of the soil analysis of the experimental site for the year 2013 is presented on Table 1. The soil texture of the site was sandy loam with sand, silt and clay having the proportions of 71%, 17.5% and 11.5%. The soils were moderately acidic with pH of 4.35. The percentage organic carbon was 0.95; total percentage nitrogen was very low 0.12. Extractable phosphorus was moderate 43.6 mg/kg while exchangeable potassium was found to be very low.

Table 1: Soil physico-chemical properties of the experimental site in 2013

Physical Properties	2013
Sand (%)	71.00
Silt (%)	17.60
Clay (%)	11.40
Textural class	Sandy Loam
Chemical Properties	
P^H (water)	4.35
Extractable P (mg/kg)	43.6
Total N (%)	0.12
Organic Carbon (%)	0.95
Organic Matter (%)	2.22
Ca (C mol/kg)	3.80
K (Cmol/kg)	0.20
Na (Cmol/kg)	0.22
EA (Cmol/kg)	1.10
ECEC (Cmol/kg)	2.83
BS (%)	78.70

Source: National Root Crops Research Institute Umudike, Umuahia, Abia State

Table 2: Mean monthly rainfall (mm), number of rainy days, average temperature (^{0}C) and relative humidity (%) of the experimental site in 2013 at Umudike, Abia state

Months	Rainfall (mm)	Number of rainy days	Average Temp. ^{0}C	R.H %
January	75.4	2	29.1	46
February	84.8	3	29.6	50
March	40.8	8	30.3	62
April	92.8	9	29.3	65
May	466.1	16	29.0	69
June	239.4	14	27.5	78
July	280.5	18	26.2	76
August	237.1	15	26.1	68
September	318.0	18	26.6	70
October	184.8	14	27.4	73
November	99.5	8	28.1	89
December	90.8	7	27.0	60
Total	2210	132	336.2	806
Mean	340	11	28.02	67.17
Jan.2014	-	-	-	-
Feb.2014	-	-	-	-

Source: National Root Crops Research Institute Umudike, Umuahia, Abia State

The result of average monthly rainfall at the experimental site in 2013 is presented on table 2. Average monthly rainfall ranged from75.0 to 466.1mm in 2013. The total rainfall in 2013 was 2210 with a mean monthly rainfall of 184.17mm. In 2013 average monthly rainfall was highest in May with 466.1mm. There was no rainfall in January and February 2014.

Fresh and Dry Weight of Whole Plant and Roots

The fresh weight of the whole plant and fresh weight of roots of each genotype at 40 days of drought stress in the field varied from 6.515 to 18.131g and 3.0387 to 8.5213g respectively. Their dry weights at 7 days after uprooting and drying ranged from 1.9377 to 7.3413g and 0.9723 to 3.1367g respectively. Even though there were significant differences ($p<0.05$) among the genotypes, GT1 had the highest fresh weight of 18.131g and dry weight of 7.3413g followed by RRIM 600 with fresh weight of 16.829g and dry weight of 6.7840 while RRIM 628 had the least fresh weight of 6.515g and dry weight of 1.9377g. Meanwhile GT 1 and RRIM 600 showed more tolerance to drought stress whereas RRIM 628 and Nig 800 showed the highest effect of drought when compared with other genotypes (Table 2). The same trend observed in the fresh weight of roots and dry weight of roots where also observed here, the same GT1 had the highest fresh root weight of 8.5213g and dry roots weight of 3.1367g followed by RRIM 600 with fresh root weight of 7.7540g.

Table 3: Mean fresh weight of whole plant, dry weight of whole plant, fresh weight of root and dry weight of root of 10 rubber genotypes evaluated in the field in the year 2013

Genotypes	Fresh weight(g) of whole plant 40 days after drought	Dry weight(g) of whole Plant 40 days after drought	Fresh weight (g) of roots 40 days after drought	Dry weight(g) of roots 40 days after drought
GT1	18.131	7.3413	8.5213	3.1367
Nig 800	6.720	2.5880	3.2843	1.1133
Nig 801	9.329	3.610	4.6303	1.9563
Nig 802	11.181	3.2010	5.1540	2.2037
Nig 803	13.509	4.6143	6.0880	3.0500
Nig 804	15.137	5.0540	7.2377	3.0900
PB5/51	7.021	2.0050	3.3607	1.3017
PR 107	10.997	4.3407	4.9987	1.6847
RRIM600	16.829	6.7840	7.7540	2.9400
RIMM628	6.515	1.9377	3.0387	0.9723
$FLSD_{0.05}$	3.9588	1.6354	1.6347	0.7532

The water requirement for plant growth is met from soil water stored in the plant root zone. The reduction in root growth in some genotypes may be due to soil water deficit that decreased the efficiency of plants ability to absorbed soil water and nutrients. Moreover, there were significant differences in roots development between various genotypes of *Hevea brasiliensis* (Samarappuli *et al.,* 1996). Genotypes like GT1, RRIM 600, Nig 800 and PR107 had the highest root density and this particular clones exhibited better performance under moisture stress conditions. Prolonged drought periods with distinct dry season leads to soil moisture stress differential magnitude, adversely affecting the growth and productivity of natural rubber clones (Lalani, 1998). This study concludes that RRIM 600 and Nig 804 are physiologically better adapted to water stress. Screening of clones for better root growth is an important tool to identify clones with intrinsic drought tolerance potential which may become increasingly relevant in a future climate when water becomes highly scarce.

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Studies on the Effect of Different Fertilizer Application on Soil Microbial Community, Activity and Yield of Livingstone Potato (*Plectranthus esculentus*) in NRCRI Umudike

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Abstract
A field study was conducted to evaluate and analyze the short term impacts of mineral and organic fertilizers on soil microbial community, activity and crop yield. The experiment was set up as a randomized block design in four replications at the experimental field of the NRCRI Umudike, in 2016 planting season. Livingstone Potato (Plectranthus esculentus) was used as the test crop. The trail involved four treatments: non-fertilized (control), Nitrogen Phosphorous potassium (NPK) fertilizer, Poultry manure (PM), Lime (LM) and combination of (NPK+PM+LM). Soil samples were collected from the experimental soil before and after treatments at monthly interval for 3months. The results obtained suggest that the bacterial count at initial stage were low compared to treated soil, which showed that bacterial and fungal counts increased at the second month compared to first and third months, and bacterial count was higher than the fungal count in all the treatments which has a stimulating effect on bacterial micro-flora variation during the growing period. Poultry manure (PM) which induced the highest increase in microbial counts of ($128.33 x10^6 \pm 2.51$ cfu/g), followed by NPK and treatment combination (NPK+PM+LM), while Lime (LM) gave the lowest of ($73.33\ x10^6 \pm 2.51$ cfu/g) during the first month. A similar effect was seen on fungal counts which PM gave the highest of ($19.00\ x10^2 \pm 1.73$), followed by NPK, NPK+PM+LM and significantly reduced with Lime LM ($5.66x10^2 \pm 1.15$) and control ($8.33x10^2 \pm 1.12$). The trend was same in the second and third month respectively. The result of the yield showed that PM gave the highest yield of 24.0 t/ha, followed by treatment combination (NPK+PM+LM) with a yield of 19.7 t/ha. Lime (LM) gave the lowest yield of 5.5 t/ha. The effects of different amendments were observed, thereby confirming that some effects of integrated fertilizer strategies may occur in the short term.
Keywords: Microbial diversity, Fertilization, Microorganisms, Soil, Organic/Inorganic Manure and Livingstone Potato

Introduction
Fertilization is one of the most significant cultural practices in modern agricultural production and these fertilizers play a vital role in food safety in Africa over the past years. However, application of chemical fertilizers caused the degradation of soil quality, such as soil acidification and soil hardening (Blake *et al.,* 1999). Mineral fertilizer and organic manure maintain or improve crop yields and induce changes in soil chemical, physical and biological properties. These changes, in the long-term, are believed to have significant influences on the quality and productive capacity of the soil (Zhang and Wang, 2006). Soil microorganisms are involved in various biochemical processes and play a vital role in maintaining soil fertility and plant yields (Nannipieri *et al*., 2003). Changes in the activity and diversity of soil microbes may reflect changes in soil quality. Therefore, the judicious and efficient use of mineral fertilizers (e.g. Nitrogen, Phosphorus, Potassium (NPK), Lime (LM) etc.) and organic fertilizers (Poultry Manure (PM), cow dung etc.) can be practicable and adopted by farmers when the approach has considered some microbiological studies. Microorganisms are critical to the maintenance of soil function because of their contributions to soil structure formation, decomposition of organic matter, toxin removal, and the biogeochemical cycling of carbon, nitrogen, phosphorus, and sulphur. The extent of soil microbial diversity in agricultural soils made it critical for the maintenance of soil health and quality, growth and yield of crops (Mele and Crowley, 2008). A

study was carried to investigate the effect of fertilizer sources on microbial structure and root yield of livingstone potato on an Ultisol of southeastern Nigeria.

Materials and Methods

A field experiment was established on a loamy soil at the agricultural experimental field of National Root Crops Research Institute Umudike, Abia State to study the short-term effect of different fertilizer amendments on soil microbial activity and root yield of Livingstone potato (*plectranthus esculentus*). The research plots were established on 22nd april 2017, in a randomized complete block design (RCBD) with four replications. Each plot size measured 15m^2 (3 m x 5 m) and the spacing between the plot was 1 m. The test plant used in the experiment was Livingstone potato (*plectranthus esculentus*). Treatments which comprised: Control (without fertilization); NPK) fertilizer at 400 kg/ha; Poultry manure (PM) at 5 t/ha; Lime (LM) at 2t/ha; and treatments combination (NPK + PM + LIME) were applied two days before planting. Livingstone potato was planted at a spacing of 0.7 m between rows and 0.25 m within row.

Soil Sampling and Bioassay

Soil sampling was done in accordance with the method of (Saeki and Toyota, 2004). Soil samples were collected from the plots before treatment and after treatments at monthly intervals, and the top soil sample was collected from depth of (0-20 cm) at four randomly selected locations in each of the plot. Composite samples were collected from each plot and stored in a sterile polypropylene bag and kept cool using coolers during field sampling. The composite samples were homogenized and sieved twice using meshes (2.0 and 0.2 mm) in order to remove stone and plant debris. Samples were subsequently processed within 24 - 48 hour for further analysis. Microbial analysis was carried out four times at monthly intervals: 1st month (before treatments application); 2nd month (after plant emergence on 31st June); 3rd month (after flowering on 29th July); and 4th month (at the end of the growing season on 22nd August).

Microbiological Analysis and Enumeration

One gram (1g) of each of the soil samples was weighed and agitated in 9 ml of distilled water, to dislodge the organisms from the soil particles. An aliquot of 1 ml was serially transferred from each sample into series of test tubes containing sterilized distilled water to obtain dilution of 10^{-1} and 10^{-10}. The microbial population was enumerated which involved determination and count of total viable microorganisms in the experiment using the method of dilution on specific solid media spread plate technique series of 10-fold serial dilution. Aliquot (0.1ml) of 10^{-2}, 10^{-4}, 10^{-6} and 10^{-8} was inoculated into nutrient agar plated in triplicates (Chikere *et al*., 2009). Total soil fungi were enumerated by inoculating aliquots (0.1ml) and determined using Sabouraud dextrose agar (SDA) supplemented with streptomycin (1 mg/100 ml) to suppress bacterial growth with the diluted soil samples of 10^{-3}. The plates were all incubated aerobically at room temperature (30^0C) for 24hours (bacteria) and fungi for 96 hours. The resulting colonies were counted and recorded as colony forming units per gram (CFU/g) using colony counter (Onifade *et al*.,2007). The counts were characterized based on cultural characteristics, staining reaction and biochemical tests.

Yield determination*:* Harvesting was done at the end of the growing season (4 MAP). Root yield of Livingstone potato were weighed and recorded per plot.

Statistical Analysis: The data was subjected to an analysis of variance (ANOVA Statistica SPSS 5), using a GENSTAT and the significant effects between individual-factor level and interaction means were separated using DNMR Test level ($p \le 0.05$).

Results and Discussion

The results obtained suggest that soil microbiological characteristics, Livingstone potato yield were significantly affected by fertilization and the growing period. Initial soil microbial counts indicated that bacterial count in the soil before treatments application was 78.33 x 10^6 CFU/g, while fungal count was 5.53 x 10^2 CFU/g (Table 1). Among all the treatment, the highest significant differences is in bacterial population, recorded across the periods of sampling (115.33 x106±1.15 CFU/g for 1st month, 128.33 x106±2.51 CFU/g for 2nd month and 114.00 x106±2.00 CFU/g for 3rd month), and these were obtained from plots that received PM treatment (Table 2). Poultry manure (PM) provided organic substrates that proliferated bacterial population and activities in the soil, as they breakdown soil organic matter and multiply in the soil, which accounted for the highest bacterial count that peaked in the 2nd month of sampling. Mandal *et al*. (2007) had posited that organic substrates intensify mineralization processes in the soil and increase enzymatic activities of soil microorganisms. The ability of PM to increase bacterial count in the soil was followed by the application of NPK fertilizer which accounted for 107.33x10^6±1.52, 144.33 x10^6±2.88, and 105.00 x10^6±1.73 CFU/g at 1st month, 2nd month and 3rd month of sampling, respectively. The activity of NPK highlighted the significant roles nitrogen and phosphorus play in symbiotic and mycorrhzal relationships with soil micro-organisms. The positive effects of chemical fertilizer on soil biological parameters during the first months of application have been reported (Park *et al*., 2005; Emtsev *et al*., 2010). Lowest values of bacterial count where obtained from plots that were treated with lime. (LM) except at 2nd month of sampling, when the Control recorded the lowest bacterial count (84.00x10^6±2.00 CFU/g) significantly. This may be attributed to the modification of the soil rhizosphere to and alkaline condition by the lime applied which is antagonistic to bacterial growth Results obtained from the study also showed that sampling at 2 months of application of fertilizer materials resulted in the highest mean bacterial count of 96.1 x 10^6 CFU/g. Application of PM also gave the highest yield of 24.0 t/ha. Application of lime at 2 t/ha did not improve yield, as it yield 5.5 t/ha of Livingstone potato roots.

Table 1: Initial soil microbial count.

Microbial soil sampling	Microbial counts (CFU/g)
Bacterial	78.33 x10^6
Fungi	5.53x10^2

Table 2 Effect of different fertilizers applications on soil bacterial mean count (CFU/g) and root yield of Livingstone potato in 2016

	Sampling period			
Treatments	**1st month**	**2nd month**	**3rd month**	**Root yield (t/ha)**
NPK	107.33 x10^6±1.52 ^{d}	144.33 x10^6±2.88 ^{d}	105.00 x10^6±1.73 ^{d}	10.5
PM	115.33 x10^6±1.15 ^{e}	128.33 x10^6±2.51^e	114.00 x10^6±2.00 ^{e}	24.0
LM	73.33 x10^6±2.51 ^{a}	87.66 x10^6±1.52 ^{b}	76.66 x10^6±2.30^a	5.5
NPK+PM+LM	102.66 x10^6±1.50 ^{c}	110.00 x10^6±2.00 ^{c}	95.33 x10^6±1.52 ^{b}	19.7
Control	88.70x10^6±3.05 ^{b}	84.00x10^6±2.00 ^{a}	86.66x10^6±2.51 ^{c}	6.8

Values show mean of triplicates analysis ± standard deviation. Figure with different superscripts down the column were significantly different at $P \leq 0.05$

Results obtained from the study also showed that sampling at 2 months of application of fertilizer materials resulted in the highest mean bacterial count of 128.33 x10^6±2.51 CFU/g. Application of PM also gave the highest yield of 24.0 t/ha. Application of lime at 2 t/ha did not improve yield, as it yield 5.5 t/ha of Livingstone potato roots. Table 3 showed effect of the fertilizer materials on fungal count and root yield of Livingstone potato at different months of sampling. Results obtained showed that PM significantly increased fungal count more than other treatments at any period of sampling. Lowest values of fungal count were recorded on plots that received LM treatment, at all sampling period. This indicates that PM promotes fungal growth in the soil, while LM inhibits fungal growth in the soil. The mean values of fungal numbers per gram of soil across the 3 sampling periods, due to treatments applied increased in this order: PM (19.00 x10^2±1.73), NPK+PM+LM (14.33x10^2±0.57 CFU/g), NPK (12.33 x10^2±1.15 CFU/g), Control (8.33x10^2±1.15 CFU/g), LM (5.66x10^2±1.15 CFU/g). Fungal load induced by PM was highest at the 1st month (17.0 x 10^2 CFU/g) and least at the 3rd month (10.33 x 10^2 CFU/g) significantly. Similar trend was observed for effect due to NPK treatment. Yield response of sweet potato to different sources of fertilizers showed that PM promoted bacterial and fungal growth and activities at all stages of Livingstone potato growth with a resultant highest increase in root yield of 24.7 t/ha. Lime treatment alone depressed yield of Livingstone potato in the studied soil.

Table 3 Effect of different fertilizers applications on soil fungal mean count (CFU/g) and root yield of Livingstone potato in 2017

Treatments	Sampling period			Root yield (t/ha)
	1st month	2nd month	3rd month	
NPK	12.33 x10²±1.15	9.66 x10²±0.57 c	7.66 x10²±0.57 b	10.5
PM	19.00 x10²±1.73	16.66 x10²±1.15 e	12.33x10²±1.15 d	24.0
LM	5.66x10²±1.15	6.66x10²±0.5 7b	8.66x10²±0.60 c	5.5
NPK+PM+LM	14.33x10²±0.57 d	12.00x10²±1.00 d	11.66x10²±0.57 e	19.7
Control	8.33x10²±1.15 b	6.66 x10²±1.15 b	6.33 x10²±0.57 a	6.8

Values show mean of triplicates analysis ± standard deviation; Figure with different superscripts down the column is significantly different at P≤0.05.

Conclusion

The study showed that bacterial and fungal counts increased at the second month compared to first and third months, and bacterial count was higher than fungal count in all the treatments which has a stimulating effect on bacterial micro-flora variation during the growing period. A positive effect of NPK fertilizer on soil biological parameters during the first months of treatments application was also observed. Poultry manure induced the highest increase in microbial count and yield of livingstone potato. Lime gave the lowest microbial counts in all the months compared to control as well as the lowest yield, this might be as a result of changes in environmental conditions for microbial growth, and lime is effective in increasing soil pH, which reduces soil acidity at the detriment of the soil microorganism.

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ASN 52nd Annual Conference Proceedings

Evaluation of Rice Genotypes for the Agronomic Performance and Resistance against *Magnaporthe oryzae*

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Abstract
Rice blast caused by fungus Magnaporthe oryzae is one of the major fungal disease affecting rice (Oryza sativa) cultivation. Currently, the use of pesticides has proven to be successful in the control of this disease to a very large extent, but these results in increase in the cost of production and these chemicals are sometimes not eco-friendly. Therefore, the deployment of blast-resistant cultivars is the most important method of combating the disease because it is considered as a no-cost technology especially to the poor farmers. Therefore, this study was carried out to evaluate rice genotypes for resistance to natural population of blast pathogens and there agronomic performance. Fifteen NCRI advance rice breeding lines and two released (BR1-17) varieties (checks) were collected from the breeding unit of the National Cereals Research Institute (NCRI), Badeggi, Nigeria. These genotypes were screened for resistance to blast disease caused by Magnaporthe oryzae in the blast hot spot and water stress environment. The results on agronomic performance reveal different reactions. Genotype BR3 was highly resistant and has the least disease incidence of 28%. BR2 is moderately resistant and also gave the highest grain yield 6tons per hecter. The blast incidence and severity did not affect the agronomic performance of the rice genotypes as most of the genotypes yield above the average grain yield of 3tons/hectare. BR3 may therefore be utilized by incorporating it into the breeding programme strategy to control blast disease of Magnaporthe oryzae .

Introduction
Rice is an extremely important food in Nigeria with a total annual production of about 2 million metric tons. It is a staple food for both rural and urban dwellers in Nigeria and it is ranked the fourth most important cereal crop in terms of production (after sorghum, maize and millet)(Abo *et al.,* 2003). Nigeria is the largest rice importer in West Africa despite having about 5.0 million hectares of land suitable for rice cultivation (Smith, 2007). Rice production in Nigeria is faced by several biotic and abiotic limitations, and prominent among the biotic factors is yield loss due to diseases. Among these diseases, leaf blast caused by *Magnaporthe oryzae* remains a particular threat because of its unpredictable outbreaks as well as breaking down of genes in resistant cultivars over time (Jamal-U-deen *et al.,* 2012). Leaf blast is one of the most serious and widespread constraint of rice cultivation in Nigeria. It occurs in upland and rainfed rice field. Water deficiency predisposes the rice field to severe infection in all environments (Akator *et al.,* 2013). Currently, the use of pesticides has proven to be successful in the control of this disease to a very large extent, but these results in increase in the cost of production and these chemicals are sometimes not eco-friendly. Therefore, the deployment of blast-resistant cultivars is the main methods of combating the disease because it is considered as a no-cost technology especially to the poor farmers (skamnioti and Gurr, 2009). Therefore the objective of this study focused on field evaluation of seventeen rice genotypes to confirm their resistance to natural population of blast pathogen under water stress environment. The agronomic performance of the rice genotypes and their resistance to diseases will facilitate their selection and incorporation into the breeding programs in Nigeria. It is on this note that the study on evaluation of Rice Genotypes for the Agronomic Performance and Resistance against *Magnaporthe oryzae* was investigated.

Materials and Methods

Collection of Materials

Fifteen NCRI advance rice breeding lines and two released varieties (checks) were collected from the breeding unit of the National Cereals Research Institute (NCRI), Badeggi.

Study Area

The study was conducted at hydromorphic field (latitude N9^{o}.04'02.05 and longitudes E6^{o}.01'30.31) of the National cereals research institute, Badeggi, Niger state, Nigeria during 2017 cropping season.

Experimental Design

The experiment was laid out in a randomised complete block design and replicated 3 times and each entry was planted to a 2 x 5m^2 plot size.

Other Agronomic practices

Fertilizer application was at 80, 40, 40kg per ha of N, P_2O_5 and K_2O, with N applied in two splits at 21 and 42 days after planting. Weeds were controlled using two herbicides (propanol and 2-4-D formulation) at 4 litres per hectare of Orizo plus with supplementary hand weeding.

Data collection and Analysis

The data regarding the occurrence of the blast disease were collected at seventh week after planting using the Standard Evaluation System developed by International Rice Research Institute (IRRI, 2013) and then converting into percentage disease by using the formula thus:

$$\text{Disease (\%)} = \frac{\text{Average of the disease score X 100}}{9}$$

Other data collected include agronomic traits such as Plant Height measured using metre rule, number of tiller per metre square, number of panicle per metre square, days to 50% flowering, 1000 grain weight and yield. Data was analyzed using CropStat7.2. version. Analysis of variance was carried out and significant means was separated using LSD @0.05% probability level

Results and Discussion

The rice genotypes showed different reactions in response to blast. Scoring of 1 in the susceptible local check (FARO 52) indicated probably that there is genetic mutation of the variety against blast as the environment was suitable for disease screening. There were 2 resistant (R) varieties, 5 moderately resistant (MR) and 9 moderately susceptible (MS) varieties (Table 2). Barnwal *et al.,* (2012), singh *et al.,* (2010) and Ali *et al.,* (2003) also observed variation in the reaction of rice genotypes to leaf blast. Significant difference at 5% level of probability was also observed for percentage blast incidence and blast severity (Table 3). Significant difference at 5% level of probability was also observed for number of tiller/m^2 and grain weight across the means of all the rice lines evaluated. Means of plant height, panicle/m^2, 50% flowering and grain yield were significantly different at 5% level of probability (Table). Highest number (78.6 and 280) of plant height and tiller/m2 were recorded in BR8 respectively. BR12 recorded the highest number (450g) of panicle/m2 followed by BR6 (431) (Table 4) though has the highest percentage blast incidence 43% and severity scoring of 5 across all the genotypes (Table 3 & 4). The susceptibility of this genotype may be as result of genetic makeup from the parents. Most of the genotypes gave grain yield above 3t/ha, though BR2 significantly at 5% gave higher grain yield of 6190kg/ha than all other entries (Table 4). Lowest grain yield was recorded in BR 11.

Majority of the genotypes yield above 3tons which is the average expected yield under the natural blast infection. The resistant genotype is therefore recommended for incorporation in to the breeding program in Nigeria.

Table 1: Phenotypic Difference to Resistance

Rice Lines	Blast Host Behaviour
BR3 &FARO 52	R
BR1, BR2, BR4, BR5, BR7 & BR13	MR
BR6,BR8,BR9,BR10,BR11,BR12,BR14, BR15 & FARO 44	MS

BR-Breed Rice, R-Resistsnce, MR-Moderately Resistance &MS-Moderately Susceptible

Table 3: Blast disease incidence and severity of the rice genotypes

Treatment No	Designation	% Blast Incidence	Blast severity
1	BR1	38	4
2	BR2	32	2
3	BR3	28	1
4	BR4	32	3
5	BR5	42	2
6	BR6	43	5
7	BR7	35	2
8	BR8	32	4
9	BR9	38	4
10	BR10	37	4
11	BR11	37	4
12	BR12	40	4
13	BR13	32	3
14	BR14	33	4
15	BR15	35	4
16	FARO 44	35	4
17	FARO 52	37	1
	LSD 5%	15.1093	2.47551
	CV%	25.4	46.6

Table 4: Agronomic performance of rice genotypes/varieties under natural field infection of Blast pathogen (*Magnaporthe oryzae*) at NCRI hydromorphic field, Badeggi

Treatment No	Designation	Plant Height	Tiller No/m²	Panicle/ m²	50%Flowering	1000 Grain weight(g)	Grain Yield(kg)
1	BR1	56.1	207	371	62	23	3443
2	BR2	59.8	228	414	63	23	6190
3	BR3	51.3	260	390	62	23	3837
4	BR4	65.7	227	413	84	27	4387
5	BR5	59.9	217	431	90	23	3033
6	BR6	61.3	217	377	79	23	4443
7	BR7	71.4	240	403	77	27	3080
8	BR8	78.6	280	383	90	23	3730
9	BR9	58	253	398	75	27	2990
10	BR10	69.7	232	433	66	23	1650
11	BR11	58.4	212	450	70	30	4200
12	BR12	61.5	255	424	75	23	3133
13	BR13	54.9	220	422	66	23	3123
14	BR14	64.4	308	400	70	30	3243
15	BR15	49.9	163	342	64	20	3160
16	FARO 44	59.6	237	413	64	27	3167
17	FARO 52	54	259	374	72	30	4313
	Lsd 5%	13.3618	81.856	45.426	4.19056	9.53087	175.833
	CV%	13.2	20.8	6.8	3.7	22.8	2.9

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Effect of Biofertilizer on Physiological Characteristics, Growth and Biomass Yield of Aerobic Rice Genotypes

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Abstract

Two field experiments were conducted at University Putra Malaysia (UPM), Selangor, Malaysia during off season (May to September) and main season (September to December) of 2015 to evaluate the effect of biofertilizer on physiological characteristics, growth and biomass yield of aerobic rice genotypes. The experiment consisted of five (5) fertilizer combinations (chemical fertilizer recommended rate (CFRR) (150 N; 60 P_2O_5; 60 K_2O kg ha^{-1}) 100%, biofertilizer 1 ton ha^{-1} + 75% CFRR, biofertilizer 2 tons ha^{-1} + 50% CFRR, biofertilizer 3 tons ha^{-1} + 25% CFRR and biofertilizer 4 tons ha^{-1}) and three aerobic rice genotypes (MRIA1, MR219-4 and MR219-9) laid out in a split-plot design in randomized complete block arrangement with 3 replicates. Results revealed that application of biofertilizer 1 ton + 75% CFRR produced plant height (90.75 cm) and a number of tillers (321.42 no. m^{-2}) at 12 weeks after sowing (WAS), the highest photosynthesis rate (16.34 µmol CO_2 m^{-2} s^{-1}) and transpiration rate (6.13 µmol CO_2 m^{-2} s^{-1}) than the other biofertilizer treatments. MR219-4 produced the highest leaf area (25776.00 cm^2 m^{-2})), plant biomass (764.22), leaf photosynthesis (16.29 µmol CO_2 m^{-2} s^{-1}) and transpiration rate (6.13 µmol CO_2 m^{-2} s^{-1}) while MR219-9 produced the highest number of tillers (358.29 no. m^{-2}) and crop growth rate (85.47 g m^{-2} $week^{-1}$) at 12 WAS. The trend in these results indicated that biofertilizer tend to be more effective with limited chemical fertilizer. These results concluded that 1 ton biofertilizer + 75% CFRR and MR 219-4 enhances rice growth in aerobic condition.

Introduction

Aerobic rice production system is an innovative way of cultivating rice in highly drained, non-puddled, and non-saturated soils without standing water. This method uses specialized rice varieties those respond to inputs and balanced management practice to achieve a minimum of 4 to 6 tons per hectare yield with just fifty percent (50%) to seventy percent (70%) of the water requirement for rice production under irrigation (Akter et al., 2016).In this method, the land is prepared under dry condition and brought to a fine tilt, the seeds are sown by dibbling in a determined ratio of rows with adequate spacing and soil moisture condition is retained almost close to field capacity (Shanmuganathan, 2006). Biofertilizers are progressively becoming popular in many countries, for many crops and are one of the complementary sources for the inorganic fertilizers. It enhances growth by increasing the primary nutrients to the host plant or supplying phytohormones to the plant (Vessey, 2003). The collective phytohormone, produced by the bacteria is indoleacetic acid, which promotes plant root growth. Additionally, biofertilizer as the organic fertilizers comprises beneficial microbes which increased crop production (15 to

50%) (Panhwar, *et al*., 2014). Biofertilizer application increases the population of microorganisms that can convert plant nutrients to the available form in soil (Vessey, 2003). It is found that application of organic and biofertilizer enhances the growth and yield of rice and able to reduce inorganic fertilizer application (Ngoc *et al*., 2001). Biofertilizer can be an effective approach to minimize chemical fertilizer sources and ultimately develop soil fertility. The main mechanisms of biofertilizer for improving plant growth include; increases nitrogen availability by fixing atmospheric nitrogen, solubilizing insoluble organic and inorganic P by producing organic acids and enzymes, and promoting root growth by indoleacetic acid (IAA) (Naher *et al*., 2009; Panhwar *et al*., 2012). To face the upcoming challenges of food production, energy consumption, and adverse environmental consequences, biofertilizer, which is prepared with the residue of plant material and beneficial environment-friendly bacteria can be a supplement to chemical fertilizer. It can be assumed that biofertilizers could offer an opportunity for rice farmers to increase yields and productivity. This study was conducted to determine the effect of biofertilizer in combination with chemical fertilizer on physiological characteristics, growth and biomass yield of three aerobic rice genotypes in field condition.

Materials and Methods

Experimental site: Field 10 University Putra Malaysia (UPM), (latitude 3^0 02'N; longitude 101^0 42' E and on the altitude of 31 m above sea level) Selangor, Malaysia. The experimental site was previously planted with sweet corn and was cleared of the debris prior to land preparation. Sweet corn was previously planted at the experimental site and the debris was cleared off prior to land preparation. Soil analysis of the experimental site revealed that the soil was clay loam with pH value of 6.50 and 6.42, total carbon (C) 0.79 and 0.77%, total nitrogen (N) 0.06 and 0.07%, total sulphur (S) 0.02 and 0.0.2%, phosphorus (P) 84.7 and 165.2 µg g-1, potassium (K) 41.24 and 55.07 µg g-1 were recorded in off and main season, respectively. The total rainfall received during the experimental periods was 548 and 1438 mm in the off and main season respectively. Maximum and minimum temperatures recorded in the off and main season were 33. 5 and 33°C, 25.25 and 24.5°C, average 29 and 28.5°C respectively

Experimental materials Aerobic rice varieties: MRIA1 aerobic rice genotypes obtained from Malaysian Agriculture Research and Development Institute (MARDI) and; MR219-4 and MR219-9 obtained from Malaysian Nuclear Agency were used for the experiments.

Preparation of biofertilizer: The prepared biofertilizer used constituted a nitrogen-fixing bacteria conglomeration (*Bacillus sp.* Sb35 and 42) and bacteria for the solubilization of phosphate (*Bacillus sp.* PSB16). One liter of each inoculum was diluted in 4 liters of distilled water (dH_2O) + molasses in soil microbiology laboratory (bacteria). Preparation of the biofertilizer was done in the biofertilizer processing laboratory glasshouse field 2 using empty fruit bunch (EFB) and peat moss in the ratio of 1:1:1. For the bacteria to multiply prior to application, the prepared biofertilizer was stored at ambient room temperature for one month.

Treatments and experimental design: The treatments comprised of five (5) biofertilizer combinations (chemical fertilizer recommended rate (CFRR) (150 N; 60 P_2O_5; 60 K_2O kg ha^{-1}) 100%, biofertilizer 1 ton + 75% CFRR, biofertilizer 2 tons + 50% CFRR, biofertilizer 3 tons + 25% CFRR, biofertilizer 4 tons) and three aerobic rice genotypes (MRIA1, MR219-4 and MR219-9). The experiments were laid out in a split-plot design in a randomized complete block arrangement with 3 replicates, with biofertilizer in the main plot and aerobic rice genotypes in the sub-plots.

Crop husbandry practices: Land was ploughed and rotovated to obtain a fine tilth and then marked out as required plot sizes with 1.0 meter space between blocks and 0.50 m spacing between plots. The gross and net plot sizes were 2.5 m × 1.5 m (3.75 m^2) and 2.0 m × 1 m (2.0 m^2), respectively constituting 6 rows in the gross plots and 4 rows in the net plots, respectively. Sown seeds were speciously treated with 70% chlorox (5.25% sodium hypochloride solution) for 30 minutes then rinsed with sterile water (Amin *et al*., 2004). Sowing was done on 24th May 2015 and 3rd September 2015 at an intra and inter-row spacing of 25 cm × 25 cm. Ten (10) dry treated rice seeds were sown $hill^{-1}$ that was later thinned to 5 seedlings $hill^{-1}$ at 14 days after sowing (DAS). 'Butachlor' herbicide (1.2 kg a.i ha^{-1}) was sprayed 2 DAS in main season only. In both seasons, 'Basagran' herbicide (bentazone 0.8 kg a.i ha^{-1} and MCPA 0.12 kg a.i ha^{-1}) was sprayed 21 and 28 DAS in off and main season, respectively followed by manual weeding throughout the growing seasons to control weeds. A day before crop establishment, biofertilizer was incorporated into the soil. Compound fertilizer (NPK 15:15:15) was applied at the rate of 400 kg ha^{-1} as basal; and Urea at the rate of 196 kg ha^{-1} in two split doses by side placement at 28 and 56

DAS to supply total recommended nutrients of 150 N; 60 P_2O_5; 60 K_2O kg ha^{-1}. Both were applied as prescribed by the treatments. The crop was grown rain-fed but supplemental irrigation was carried out using a sprinkler to keep the soil at field capacity throughout the growing season.

Parameters measured

Agronomic parameters: Five (5) rice hills from each net plot of all the treatments were randomly sampled and their height was measured at 4, 8 and 12 weeks after sowing (WAS). A number of tillers were counted manually following the same interval. Leaf area and plant biomass were determined at 4, 8 and 12 WAS. One rice hill $plot^{-1}$ was randomly sampled, uprooted and washed to remove all soil particles adhering to the shoot and root. The samples from the field were then brought to the laboratory for leaf area measurement using leaf area meter (MODEL: LI-3100 AREA METER, USA). A constant weight was achieved by oven drying the samples at 70 ^{0}C for 72 hours after the measurement, the plant biomass was then weighed using digital balance and readings were recorded.

Physiological parameters: The chlorophyll content was measured from fully expanded healthy leaves 4 weeks interval starting from 4 weeks after sowing using a portable chlorophyll meter (MINOLTA ™ SPAD-502, Minolta camera Co, Osaka, Japan). The youngest fully expanded leaf (YEL) of each plant an average of 15 leaves $plot^{-1}$ (5 leaves $hill^{-1}$) SPAD readings were recorded. A portable photosynthesis system (LI-6400XT, LI-COR Inc. Lincoln, Nebraska, USA) was used for the measurement of single leaf net photosynthesis and transpiration at 75 and 65 DAS in off season and main season respectively. The measurements were carried out under full sunlight and at constant CO_2 of 380 µmol CO_2 mol^{-1} in the chamber. Crop growth rate (CGR) at 4, 8 and 12 WAS was calculated using the equation CGR = $\frac{w2 - w1}{t2 - t1}$ (g $hill^{-1}$ $week^{-1}$)

Where w_2 and w_1 are dry shoot weight taken at two consecutive harvest time's interval t_2 and t_1

Results and Discussion

Plant height and Number of tillers

Effect of season and biofertilizer on the genotypes of rice and their interaction on plant height and number of tillers is presented in Table 1. At 4 WAS, the tallest plants (43.83 cm) were recorded in the main season. In biofertilizer treatment, the height (37.42 cm) of plants recorded in 100% CFRR was similar ($p>0.05$) to that of biofertilizer 1 ton +75% CFRR (35.98 cm) and biofertilizer 2 tons +50% CFRR (35.59 cm) but significantly ($p\leq0.05$) higher than other biofertilizer treatments. MRIA1 recorded higher (43.65 cm) plant height than the other genotypes. At 8 WAS, the tallest plants (79.32 cm) were significantly produced in the main season. MRIA1 recorded the tallest (90.67 cm) plants. At 12 WAS, the tallest plants (94.58 cm) were significantly produced from CFRR 100% while the shortest (83.73 cm) plants were significantly produced from biofertilizer 4 tons at par with the other biofertilizer treatments except for CFRR 100% and biofertilizer 1 ton + 75% CFRR; and biofertilizer 2 tons + 50% CFRR respectively. Similar to 8 WAS, MRIA1 recorded the tallest (102.66 cm) plants. At 4 WAS, the highest (194.84 no. m^{-2}) number of tillers were significantly produced in main season while MR219-4 significantly produced more (162.28 no. m^{-2}) number of tillers at par with MR219-9. MRIA1 significantly produced the least (99.51 no. m^{-2}) number of tillers. At 8 WAS, more (310.19 no. m^{-2}) number of tillers were significantly produced in the main season. More (313.76 no. m^{-2}) number of tillers were significantly produced by MR219-4. MRIA1 significantly produced the least (115.38 no. m^{-2}) number of tillers. At 12 WAS, biofertilizer 2 tons + 50% CFRR significantly produced more (350.93 no.m^{-2}) number of tillers. Least (259.56 no. m^{-2}) number of tillers were significantly produced from biofertilizer 4 tons. MR219-4 significantly produced more (381.23 no. m^{-2}) number of tillers. MRIA1 significantly produced the least (197.87 no. m^{-2}) number of tillers.

Table 1: Plant height (cm) and umber of tillers (no. m^{-2}) of aerobic rice as influenced by season, biofertilizer, genotype and their interactions for two seasons combined

	Plant height			Number of tillers		
	4 WAS	**8 WAS**	**12 WAS**	**4 WAS**	**8 WAS**	**12 WAS**
Season (S)						
Off season	25.90b	52.89b	81.71a	87.45b	168.13b	320.71a
Main season	43.83a	79.32a	96.25a	194.84a	310.19a	304.21a
Biofertilizer (B)						
CFRR 100%	37.42a	70.12a	94.58a	141.20a	276.88a	350.93a
Biofertilizer1ton + 75% CFRR	35.98a	66.97a	90.75ab	146.65a	247.53b	321.42ab
Biofertilizer 2 tons + 50% CFRR	35.59ab	65.22a	88.94b	141.67a	230.23bc	323.02ab
Biofertilizer 3 tons + 25% CFRR	32.49b	65.02a	86.91bc	133.76a	228.32bc	307.38b
Biofertilizer 4 tons	32.84b	63.22a	83.73c	142.46a	212.84c	259.56c
Genotypes (G)						
MR219-4	30.80b	55.10b	84.61b	162.28a	313.76a	381.23a
MR219-9	30.15b	52.55b	79.68c	161.65a	288.33b	358.29a
MRIA1	43.65a	90.67a	102.66a	99.51b	115.38c	197.87b
Significance level						
S	**	**	*	*	**	ns
B	**	ns	**	ns	***	***
G	***	***1	***	***	***	***
S × B	ns	ns	*	ns	ns	*
S × G	***	***	ns	**	***	*
B × G	ns	ns	ns	ns	ns	ns
S × B × G	ns	ns	ns	ns	ns	ns
Mean	34.86	66.11	88.98	141.15	239.16	312.46
CV (%)	13.52	13.07	7.49	25.25	15.90	17.23

Means in a column for each factor followed by the same letter(s) are not significantly different at P=0.05 using Duncan's new multiple range test (DNMRT), *, **, *** represent significant at P≤0.05, P≤0.01 and P≤0.001 respectively, ns = not significant at P>0.05, CFRR = chemical fertilizer recommended rate, WAS = weeks after sowing

Leaf area and leaf chlorophyll content (SPAD value)

Effect of season and biofertilizer on the genotypes of rice and their interaction on leaf area and SPAD value is presented in Table 2. At 4 WAS, the highest (5056.40 $cm^2\ m^{-2}$) leaf area was significantly produced in the main season. Biofertilizer 1 ton + 75% CFRR ha^{-1} had the highest (3923.30 $cm^2\ m^{-2}$) leaf area. Biofertilizer 4 tons significantly produced the lowest (3200.70 $cm^2\ m^{-2}$) leaf area. The highest (4119.60 $cm^2\ m^{-2}$) leaf area was significantly produced by MR219-4. MRIA1 significantly produced the lowest (2924.19 $cm^2\ m^{-2}$) leaf area. At 8 WAS, the highest (29729. 30 $cm^2\ m^{-2}$) leaf area was significantly produced in the main season. The highest (38397.60 $cm^2\ m^{-2}$) leaf area was significantly produced from CFRR 100%. The lowest (15615.80 $cm^2\ m^{-2}$) leaf area was significantly produced from biofertilizer 4 tons. MR219-4 significantly produced the highest (31258.00 $cm^2\ m^{-2}$) leaf area. MRIA1 significantly produced the lowest (11595.90 $cm^2\ m^{-2}$) leaf area. At 12 WAS, the highest (24935.60 $cm^2\ m^{-2}$) leaf area was significantly produced in a main season. The highest (26196.40 $cm^2\ m^{-2}$) leaf area was significantly produced from CFRR 100%. The lowest (15944.40 $cm^2\ m^{-2}$) leaf area was significantly produced from biofertilizer 4 tons. MR219-4 significantly produced the highest (25776.00 $cm^2\ m^{-2}$) leaf area. MRIA1 significantly produced the lowest (8021.40 $cm^2\ m^{-2}$) leaf area. At 4 WAS, the highest (37.01) SPAD value was significantly produced in the main season. The highest (37.21) SPAD value was significantly produced from CFRR 100%. The lowest (32.58) SPAD value was significantly produced from biofertilizer 4 tons. At 8 WAS, the highest (37.18) SPAD value was significantly produced in the main season while the highest (37.87) SPAD value was significantly produced from CFRR 100%. The lowest (34.76) SPAD value was significantly produced from biofertilizer 4 tons. The highest (42.22) SPAD values was significantly produced by MRIA1. Similar to 8 WAS, at 12 WAS, MRIA1 significantly produced the highest (36.80) SPAD value.

Table 2: Leaf area (cm^2 m^{-2}) and chlorophyll content (SPAD value) of aerobic rice as influenced by season, biofertilizer, genotype and their interactions for two seasons combined

	Leaf area			SPAD value		
Treatment	**4 WAS**	**8 WAS**	**12 WAS**	**4 WAS**	**8 WAS**	**12 WAS**
Season (S)						
Off season	1997.40b	16148.40b	13570.10b	32.77b	35.41b	33.04a
Main season	5056.40a	29729.30a	24935.60a	37.01a	37.18a	31.47b
Biofertilizer (B)						
CFRR 100%	3675.80ab	38397.60a	26196.40a	37.21a	37.87a	33.27a
Biofertilizer 1 ton + 75% CFRR	3923.30a	19848.30c	19310.10b	35.26b	36.12b	30.92a
Biofertilizer 2 tons + 50% CFRR	3381.30bc	21404.00b	16233.60c	35.40b	36.34ab	32.61a
Biofertilizer 3 tons + 25% CFRR	3453.30bc	19428.50c	18579.60b	34.01bc	36.40ab	32.15a
Biofertilizer 4 tons	3200.70c	15615.80d	15944.40c	32.58c	34.76b	32.34a
Genotypes (G)						
MR219-4	4119.60a	31258.00a	25776.00a	34.90a	33.37b	30.17b
MR219-9	3536.91b	25962.60b	23961.10b	35.21a	33.30b	29.81b
MRIA1	2924.19c	11595.90c	8021.40c	34.56a	42.22a	36.80a
Significance level						
S	***	***	***	**	**	**
B	**	***	***	**	**	ns
G	***	***	***	ns	***	***
S × B	***	***	***	ns	ns	ns
S × G	***	***	***	***	ns	**
B × G	***	***	***	ns	ns	ns
S × B × G	***	***	***	ns	ns	ns
Mean	3526.90	22938.80	19252.80	34.89	36.30	32.26
CV (%)	10.43	5.00	6.27	7.27	5.94	7.10

Means in a column for each factor followed by the same letter(s) are not significantly different at P=0.05 using Duncan's new multiple range test (DNMRT), **, *** represent significant at P≤0.01 and P≤0.001 respectively, ns = not significant at P>0.05, CFRR = chemical fertilizer recommended rate, WAS = weeks after sowing

Plant biomass, photosynthesis and transpiration

Effect of season and biofertilizer on the genotypes of rice and their interaction on p biomass and photosynthesis and transpiration rate is presented in Table 3. At 4 WAS, the heaviest (103.27 gm^{-2}) plant biomass was significantly produced in a main season. In biofertilizer treatments, the heaviest (137.23 gm^{-2}) plant biomass was significantly produced from biofertilizer 1 ton + 75% CFRR. Biofertilizer 3 tons + 25% CFRR significantly produced the lightest (62.24 g m^{-2}) plant biomass. The heaviest (92.03 g m^{-2}) plant biomass was significantly produced by MR219-4. MR219-9 significantly produced the lightest (62.66 g m^{-2}) plant biomass. At 8 WAS, the heaviest (455.26 gm^{-2}) plant biomass was significantly produced in the main season. In biofertilizer treatment, the heaviest (538.15 gm^{-2}) plant biomass was significantly produced from CFRR 100%. The lightest (350.65 g m^{-2}) plant biomass was significantly produced from biofertilizer 4 tons. The heaviest (520.30 g m^{-2}) plant biomass was significantly produced by MR219-4 while MR219-9 produced the lightest (368.18 g m^{-2}) plant biomass. At 12 WAS, the heaviest (712.81 gm^{-2}) plant biomass was significantly produced in the main season. In biofertilizer treatment, the heaviest (800.54 gm^{-2}) plant biomass was significantly produced from CFRR 100%. The lightest (580.54 g m^{-2}) plant biomass was significantly produced from biofertilizer 4 tons. The heaviest (764.22 g m^{-2}) plant biomass was significantly produced by MR219-4. MRIA1 significantly produced the lightest (471.69 g m^{-2}) plant biomass. The highest (18.60 µmol CO_2 m^{-2} s^{-1}) photosynthesis rate was significantly produced in the main season. The least (13.71 µmol CO_2 m^{-2} s^{-1}) photosynthetic rate was significantly produced from biofertilizer 4 tons. The highest (14.09 µmol CO_2 m^{-2} s^{-1}) photosynthetic rate was significantly produced by MR219-4 while MR219-9 significantly produced the least (10.23 µmol CO_2 m^{-2} s^{-1}) photosynthetic rate. The highest (6.23 mmol H_2O m^{-2} s^{-1}) transpiration rate was significantly produced in main season while MR219-4, significantly produced the highest (6.06 mmol H_2O m^{-2} s^{-1}) transpiration rate.

Table 1: Plant biomass (g m^{-2}), photosynthesis (μmol CO_2 m^{-2} s^{-1}) and transpiration rate (mmol H_2O m^{-2} s^{-1}) of aerobic rice as influenced by season, biofertilizer, genotype and their interactions for two seasons combined

Treatment	Plant biomass 4 WAS	8 WAS	12 WAS	Photosynthesis	Transpiration rate
Season (S)					
Off season	45.36b	390.95b	584.49b	12.32b	6.23a
Main season	103.27a	455.26a	712.81a	18.60a	4.80b
Biofertilizer (B)					
CFRR 100%	83.10a	538.15a	800.54a	15.29ab	5.28ab
Biofertilizer 1 ton + 75% CFRR	83.60a	404.89bc	612.36c	16.34a	6.13a
Biofertilizer 2 tons + 50% CFRR	78.18a	387.53c	599.94c	16.94a	6.18a
Biofertilizer 3 tons + 25% CFRR	62.24b	434.31b	720.86b	15.03ab	5.22ab
Biofertilizer 4 tons	64.44b	350.65d	509.54d	13.71b	4.77b
Genotype (G)					
MR219-4	92.03a	520.30a	764.22a	16.29a	6.06a
MR219-9	62.66c	368.18b	710.04b	14.58b	5.30b
MRIA1	68.25b	380.84b	471.69c	15.51ab	5.19b
Significance level					
S	***	**	*	***	**
B	***	***	***	*	*
G	***	***	***	*	**
S × B	***	***	ns	ns	ns
S × G	***	***	***	**	*
B × G	***	***	***	ns	ns
S × B × G	***	***	***	**	ns
Mean	74.31	423.11	648.65	15.46	5.52
CV (%)	10.70	12.52	10.60	17.13	19.88

Means in a column for each factor followed by the same letter(s) are not significantly different at P=0.05 using Duncan's new multiple range test (DNMRT), **, *** represent significant at $P \leq 0.01$ and $P \leq 0.001$ respectively, ns = not significant at $P > 0.05$, CFRR = chemical fertilizer recommended rate, WAS = weeks after sowing

Crop growth rate

Effect of season and biofertilizer on the genotypes of rice and their interaction on crop growth rate is presented in Figure 1. At 4 WAS, the heaviest (25.82 gm^{-2} $week^{-1}$) crop growth rate was significantly produced in the main season. The heaviest (20.90 gm^{-2} $week^{-1}$) crop growth rate was significantly produced from biofertilizer 1 ton + 75% CFRR. The lightest (19.60 g m^{-2} $week^{-1}$) crop growth rate was significantly produced from biofertilizer 3 tons + 25% CFRR. The heaviest crop growth rate (23.00 g m^{-2} $week^{-1}$) was significantly produced by MR219-4. MR219-9 significantly produced the lightest crop growth rate (15.67 g m^{-2} $week^{-1}$). At 8 WAS, the heaviest (113.76 gm^{-2} $week^{-1}$) crop growth rate was significantly produced from CFRR 100%. The lightest (71.55 g m^{-2} $week^{-1}$) crop growth rate was significantly produced from biofertilizer 4 tons. The heaviest (107.67 g m^{-2} $week^{-1}$) crop growth rate was significantly produced by MR219-4. MR219-9 significantly produced the lightest (76.38 g m^{-2} $week^{-1}$) crop growth rate. At 12 WAS the heaviest (71.64 g m^{-2} $week^{-1}$) crop growth rate was significantly produced from biofertilizer 3 tons + 25% CFRR. The lightest (39.72 g m^{-2} $week^{-1}$) crop growth rate was significantly produced from biofertilizer 4 tons. MR219-9 significantly produced the heaviest (85.47 g m^{-2} $week^{-1}$) crop growth rate while MRIA1 produced the lightest (22.71 g m^{-2} $week^{-1}$) crop growth rate.

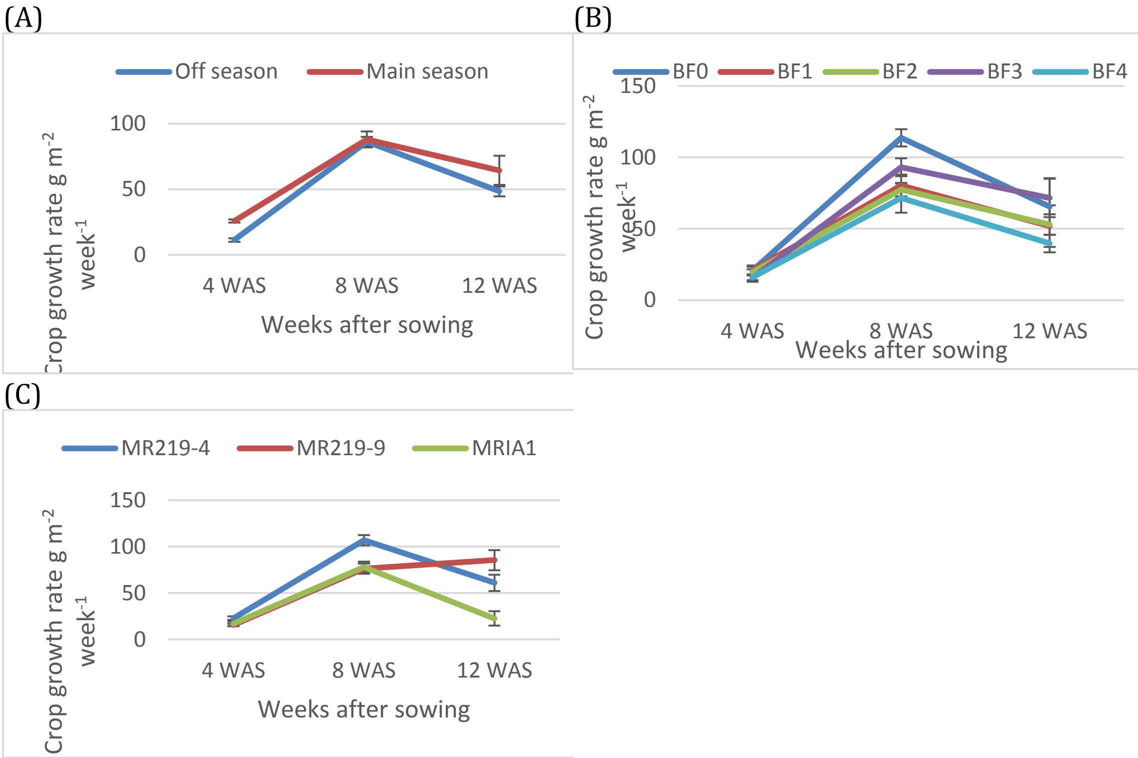

Figure 1: Crop growth rate as influenced by (A) season, (B) biofertilizer and (C) genotypes two seasons combined
Note: BF0 = CFRR 100%, BF1 = biofertilizer 1 ton + 75% CFRR, BF2 = biofertilizer 2 tons + 50% CFRR, BF3 = biofertilizer 3 tons + 25% CFRR, BF4 = biofertilizer 4 tons, CFRR = chemical fertilizer recommended rate. Error bar are SE values

Results of this experiment showed that use of biofertilizer increases the growth of rice. It also reduces the consumption of inorganic fertilizer. The helpful influence of biofertilizer on the growth and productivity of soybean, maize, sugar beet, and wheat were emphasized by nitrogen fixation ability, phosphorus solubilization, and production of phytohormones (Naseri and Mirzaei, 2010; Naseri, *et al*., 2013). These potential inoculants, its' application properly combine with inorganic fertilizer could be deliberated in the sustainable and organic cultivation of aerobic rice (Panhwar *et al*., 2011a). The considerable increase in the height of plant, number of tillers and leaf photosynthesis on biofertilizer 1 ton ha^{-1} + 75% CFRR applied plots might be due to microorganisms contained in the biofertilizer helped in the fixation of atmospheric nitrogen and solubilized the insoluble forms of phosphates into available forms thereby making these nutrients available for the crop growth. Panhwar *et al*. (2011b) reported phosphate solubilizing bacteria (PSB) strains increased plant height in aerobic rice. Their findings revealed that aerobic rice inoculation with PSB enhanced microbial phosphate solubilization activity of applied treatments. Similarly, Tambekar *et al*. (2009) reported that symbiotic nitrogen fixing and phosphate solubilizing microorganisms play a significant role in complementing plant's nitrogen and phosphorus requirement, permitting a nitrogen and phosphate fertilizers usage sustainably. From the findings of this study, about twenty-five percent (25%) of the recommended chemical fertilizer is saved. This is contrary to findings of Habibi *et al*. (2011) where they reported fifty percent (50%) of needed nitrogen and phosphorus fertilizers may possibly be substituted by bio- and organic fertilizers, since bio-and organic fertilizers enriched the efficacy of suggested nitrogen and phosphorus fertilizers and decrease chemical fertilizers costs, similarly prevent contamination of the environment from wide use of inorganic fertilizers. Naher *et al*. (2016) stated the application of chemical N and P can be reduced by fifty percent (50%) and increase rice yield with the supplement of 5 tons ha^{-1} bio-organic fertilizer. However, it was reported that when various PSB strains were used along with a half-dose of inorganic fertilizer on lettuce (*Lactuca sativa*), twenty-five (25%) growth increase was achieved in contrast with sole chemical fertilizer treatments and by applying biofertilizer at least fifty percent (50%) of chemical fertilizer could be saved (Young *et al*., 2003). With regards to the increase in chlorophyll contents, leaf photosynthesis rate, leaf area, crop biomass and crop growth rate, biofertilizer 1 ton + 75% CFRR at par with a CFRR 100% seemed to be more effective than the other biofertilizer treatments. The higher values obtained on these parameters in biofertilizer 1 ton + 75% CFRR showed the effectiveness of N-fixing and PSB inoculants in aerobic rice. The biofertilizer used in this study contains N2-fixing and phosphate solubilizing bacteria (PSB) with the capability to produce growth promoting phytohormones (IAA), organic acids and enzymes (Naher, *et al*., 2009). The beneficial features of the biofertilizer directly opinionated the physiology of rice (Panhwar *et al*., 2015a) and improved the chlorophyll contents in its leaves. Application of biofertilizer will, therefore, give rise to the fixation of some atmospheric nitrogen, which else required to be supplied from chemical N fertilizer and bio-available P. Hence, using this biofertilizer, to a certain degree, enhanced the rice growth and yield (Radziah and Panhwar, 2014). Mehrvarz *et al*. (2008) reported an increase in chlorophyll content and photosynthesis rates with inoculation of PSB. Other studies established that biofertilizer promptly enhances crop growth (Kachrooc and Razdiah, 2006; Son *et al*., 2007). Crop growth rate is a simple and important index of agricultural productivity on the rate of dry matter production. The highest crop growth rate recorded in CFRR 100% might be attributed to the larger surface area of the leaves of plants in this treatment. When leaf area is large to intercept 95% of sunlight then plant gets optimum crop growth rate and also greater light interception stimulates crop growth rate which in turn increases total dry matter and leaf area. Datta *et al*. (2012) reported that greater leaf area causes higher light interception which further enhances crop growth rate and thus results in higher yield.

Conclusion

The crop recorded higher plant height, a number of tillers, and photosynthesis rate in biofertilizer 1 ton + 75% CFRR. MR219-4 recorded higher leaf photosynthesis, transpiration, leaf area, plant biomass while MR219-9 recorded higher number of tillers and crop growth rate. Rice growth could be improved by the application of biofertilizer 1 ton + 75% CFRR on MR219- and MR219-9 genotypes in aerobic condition and thus minimizes the inorganic fertilizer application. It was concluded that 25% reduced dose of chemical fertilizer and its combination with biofertilizer was optimum for most of the parameters studied as compared to the sole chemical or biofertilizer at both crop growth stages.

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Response of Yield and Yield Components of Pre-Release Hybrid Water Yam (*Dioscorea alata*) Genotypes across Three Agro-Ecologies in Nigeria

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Abstract
The objective of the study was to evaluate responses of yield and some yield components of 12 pre-release water yam (D.alata) genotypes in three agro-ecologies within Nigeria yam belt. The trials were established at Umudike , Igbariam and Markurdi. The field was laid out in randomised complete block design (RCBD) and replicated three times. Data were captured digitally using field book app. Genotype x environment interactions determined the performance of each genotype at particular location with regards to number of emerged plant plot^{-1}, number of ware tuber plot^{-1}, ware tuber yield plot^{-1} and total fresh tuber yield plot^{-1}. However, based on yield stability across the agro-ecologies, TDa1100302 and TDa1100264 were the best performing among the genotypes and were better than the national check TDa291.

Keywords: responses, yield, hybrid, water yam, genotypes and agro-ecologies

Introduction
Yam (*Dioscorea spp*) is a tuber crop of great economic importance in tropical regions of the world. It also holds cultural significance among the ethnic tribes of West Africa and South Pacific islands; where it is highly revered and celebrated with many festivities, as the most important cultural food crop (Obidiegwu and Akpabio 2017). Yams serve as one of the most important staple food in West Africa, broadening the food base and bringing food security to about 300 million people in the low-income, food-deficit countries (LIFDCs) of the tropics and providing them with about 200 dietary calories daily (Nwogha, *et al*, 2017). Nutritionally, yams are better than cassava in terms of vitamin C content; yams contain 40-120mg g^{-1} edible portion of vitamin C and crude protein of 40-140g Kg^{-1} dry matter, and do not contain cyanogenic compounds like cassava. It has net dietary protein calorie content of about 4.6% which compares well with 4.7% in maize (Egesi, et al., 2003). In West Africa, yam is also a source of foreign exchange because its consumption is more widely dispersed than its production. It is exported from West Africa to other parts of Africa where it is not produced and to other parts of the world including Europe, North and South America and Asia where it is consumed by increasing West African immigrant populations. In Nigeria, yam contributes 18% of household food crops cash income (BMFG, 2013). It is a multi-species crop which has more than 600 known species that produce tubers, bulbils or rhizomes (Ayenus and Coursey 1972). Among the species, water yam or greater yam (*Dioscorea alata*) is the most widely distributed in the tropics and most cultivated by small holder farmers (Sartie and Asiedu 2014). The wide environments adaptability of water yam (*Dioscorea alata*) across climatic regions and agro-ecologies when compared to other *Dioscorea* species may be link to its advantageous agronomic traits such as; high yield potential, high multiplication ratio, ease of propagation (through production of tubers, bulbils and reliability of sprouting), early growth vigour for weed suppression and long storability of tubers. However, this inherent genetic advantage of water yam compared to other species in terms of yield potential and flexibility in environmental adaptation notwithstanding. The yields are still being influenced by numerous environmental factors such as rainfall (soil moisture), temperature, light, photoperiod and other edaphic factors (Oselebe and Okporie, 2008). These factors in addition to other biotic factors have led to decline in water yam productivity over the years,

prompting yam breeding objectives to be structured towards developing varieties that will be resilient to wide range of environments. Hence, the objective of this study is to evaluate pre-release hybrid water yam (*Dioscorea alata*) genotypes for their yields and yield components responses across three agro-ecologies within Nigeria yam belt.

Materials and Methods

The trials were established in 2017 at National Root Crops Research Institute (NRCRI), Umudike(humid rainforest), NRCRI out-station, Igbariam (derived savannah) and Federal University of Agriculture Markurdi (southern guinea savannah) located at 05^{0}29'09.1"N, 007^{0}32'29.5"E; 06^{0}18.732'N, 006^{0}58.101'E and 07^{0}46.310'N, 008^{0}39.979'E respectively. The locations have mean temperatures (Umudike 27.08^{0}C, Igbariam 32^{0}C and Markurdi 33.2^{0}C) and mean rainfall of 2524mm, 2000mm and 1600mm respectively. The soils of the locations belong to utisols for Umudike and Igbariam each and alfisols for Markurdi and have pH of 4.6-5.1, 5.35-5.47and 5.7-6.79 respectively.

Plant materials comprise of 11 pre-release hybrid water yam (*D. alata*) genotypes which includes; TDa297, TDa11/00204, TDa11/00300, TDa11/00264, TDa11/00193, TDa11/00316, TDa11/00201, TDa11/00302, TDa11/00477, TDa07/00015, TDa11/00203 and TDa291 that was used as check. These materials were sourced from the International Institute of tropical Agriculture (IITA), Ibadan Nigeria. Land preparations were done by tractor, the lands were ploughed, ridged and then marked into a 10m length per a plot to make the total land area of 12mx32m^2 (i e 384 m^2) each location for the experiment. Each genotype were cut into sett size of 200g and planted at space of 1mx1m and depth of 10cm between 27th April and 11th May 2017. The field was sprayed with pre-emergence herbicide 3 days after planting. Subsequently, weeding was done manually at 2 and 5 months after emergence. No fertilizer was applied as the crops were evaluated for their responses to natural soil fertility across the agro-ecologies. Single staking was done using whole bamboo stakes of 3 metres high. The experiments were laid out in randomized complete block design that has four blocks and replicated three times. Data were digitally captured on various agronomic traits of interest using field book App. Data captured were subjected to statistical analysis using Genstat software and means were separated using least significant deviation.

Results and Discussion

Variance estimates for yield components and yield of *D.alata* genotypes across three agro-ecologies within

Nigeria yam-belt

Significant genotype effect at (P<0.001) was recorded on plant vigour, number of seed tuber plot^{-1}, number of ware tuber plot^{-1}, seed tuber yield plot^{-1}, ware tuber yield plot^{-1}, and total fresh tuber yield plot^{-1}. Similarly, location significantly affected all the above traits, in addition to number of emerged plant plot^{-1}(p<0.001). However, genotype x location interaction effect was significant for number of emerged plant plot^{-1}(P<0.05), number of ware tuber plot^{-1}, ware tuber yield plot^{-1} and total fresh tuber yield plot^{-1} at (0.001) respectively.

Table1: Variance estimates for yield components and yield of *D.alata* genotypes across three agro-ecologies within Nigeria Yambelt

Source	Df	NEPP	PLNV	NSTP	NWTP	STYP	WTYP	TFTYP
Rep	2	0.45	0.04	10.56	12.79	3.31	25.35	18.83
Genotype(G)	11	1.32	0.87***	77.08***	26.81***	10.67***	74.05***	97.93***
Location(L)	2	74.18***	2.81***	348.51***	75.95***	50.63***	372.87***	148.41***
GxL	22	1.24*	0.16	7.05	8.45***	1.62	30.90***	30.36***
Error	70	0.71	0.20	15.63	3.64	2.22	9.95	9.87

Mean yield components and yield performance of *D. alata* genotypes

The twelve genotypes were significantly different (P<0.05) with respect to plant vigour, number of seed tuber plot^{-1}, number of ware tuber plot^{-1}, seed tuber yield plot^{-1}, ware tuber yield plot^{-1}, and total fresh tuber yield plot^{-1} (Table 2). TDa1100201, TDa1100264, TDa1100302, were the most vigorous across the locations, these genotypes approximately recorded the highest visual score of 3 and were not significantly different to each other, while, TDa297, recorded the least plant vigour with visual average score of 1.89. The national check TDa 291 recorded the highest of seed tubers plot^{-1}, (15.67 seed tubers), whereas, TDa1100201 recorded the least number of seed tubers plot^{-1}, (9 seed tubers). Similarly, TDa1100264 and TDa297 recorded highest and lowest seed tuber yields of 7.43Kg plot^{-1} and 4.28Kg Plot^{-1} respectively. TDa1100302 recorded the highest number of ware tuber plot^{-1} (15.56 ware tubers) and subsequently produced the highest ware tuber yield plot^{-1} 20.62Kg/plot. While, TDa 297 recorded the least number of ware tubers (10.44 ware tubers) and equally recorded lowest ware tuber yield. Similar trend was observed for total fresh tuber yield, TDa1100302 recorded produced the highest total fresh tuber yield of 26.13Kg plot^{-1} and could be ranked the best among the genotypes in terms of tuber yield across the three agro-ecologies

Table 2: Means of yield components and yield of *D. alata* genotypes across three agro-ecologies in Nigeria yam-belt

Genotype	Number of emerged plant/plot	Plant vigour	Number of seed tubers/plot	Number of ware tubers/plot	Seed tuber yield/plot(Kg)	Ware tuber yield/plot(Kg)	Total fresh tuber yield/plot(Kg)
TDa291	9.11	2.67	15.67	11.89	6.96	13.12	20.08
TDa0700015	9.11	2.78	9.44	12.56	5.52	15.11	20.63
TDa1100193	8.00	2.22	7.11	11.33	3.89	12.39	16.28
TDa1100201	8.67	2.89	9.00	14.11	4.62	17.21	21.83
TDa1100203	9.22	2.78	7.78	15.00	4.68	17.79	22.47
TDa1100204	9.33	2.78	12.67	15.22	6.41	18.79	25.20
TDa1100264	9.22	2.89	15.56	15.11	7.43	17.61	25.04
TDa1100300	9.33	2.78	9.22	14.00	4.96	16.57	21.52
TDa1100302	9.33	2.89	9.67	15.56	5.51	20.62	26.13
TDa1100316	8.89	2.78	14.33	12.22	5.83	13.23	19.07
TDa1100477	9.11	2.44	10.56	12.33	6.14	14.06	20.20
TDa297	9.22	1.89	11.89	10.44	4.28	11.34	15.62
Mean							
LSD0.05	NS	0.42	3.72	1.80	1.40	2.97	2.95

Note; ns means not significant at 5% level of probability

Effects of agro-ecologies on responses of yield and yield components of *D. alata* genotypes

Genotypes performed better in Southern guinea savannah for all yield and yield components traits phenotyped, except for seed tuber yield (Table 3). Though, in terms of total fresh tuber yield genotypes were responsive to agro-ecologies. The most responsive genotype is TDa1100203, while the non-responsive is TDa1100302. This characteristic is an indication of the genotype fair stability across the agro-ecologies where they were evaluated. Based on yield stability across the agro-ecologies, TDa1100302 and TDa1100264 were the best performing and were better than the national check TDa291. Generally, farmers would prefer high yielding genotype that will perform consistently in wide range of environments.

Table3: Effects of agro-ecologies on responses of yield and yield components of *D. alata* genotypes

Agro-ecology	Number of emerged plant/plot	Plant vigour	Number of seed tubers/plot	Number of ware tubers/plot	Seed tuber yield/plot (Kg)	Ware tuber yield/plot (Kg)	Total fresh tuber yield/plot(Kg)
Humid rainforest(Umudike)	9.89	2.4	9.31	12.94	5.93	14.54	20.47
Derived Savannah(Igbariam)	9.86	2.6	14.67	12.08	6.45	13.14	19.59
Southern Guinea Savannah(Makurdi)	7.39	2.9	9.25	14.92	4.18	19.28	23.46
Mean							
LSD0.05	0.40	0.21	1.86	0.9	0.7	1.48	1.48

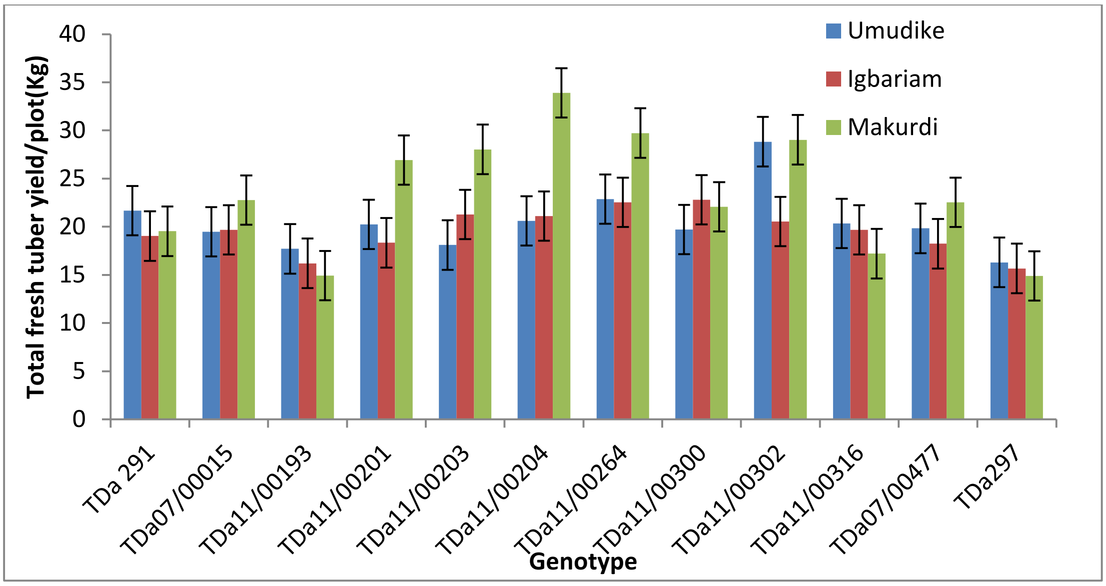

Figure 1: Effect of genotype x environment interaction on total fresh tuber yield plot^{-1} . error standard deviation value was used to insert and customised error bars, means with lower bars above the upper bars comparing means are significantly different at P=0.05

Conclusion

Genotype x environment interactions determined the performance of each genotype at particular location with regard to number of emerged plant plot^{-1}, number of ware tuber plot^{-1}, ware tuber yield plot^{-1} and total fresh tuber yield plot^{-1}. Based on yield stability across the agro-ecologies, TDa1100302 and TDa1100264 were the best performing and were better than the national check TDa291.

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Effect of *Moringa oleifera and Gliricidia sepium* Leaf Extract as Foliar Fertilizer on the Growth of *Celosia argentea*

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Abstract
A field study was conducted at the Joseph Ayo Babalola University Teaching and Research Farm, Osun State Nigeria to investigate the effect of foliar application of MLE and GLE on the vegetative growth and yield performance of Celosia argentea. The results showed that growth and yield of celosia were significantly (P<0.05) influenced by foliar application of Moringa leaf extract (MLE). The result also shows that the foliar application was significant in the evaluation of the plant height, stem girth and numbers of leaves produce the residual effects of this foliar application also improve soil physicochemical characteristics. With improvement in N, P, K, Ca and Mg. that was in moderate form during the pre-planting test. There was significant increase in herbage yield also with the application of Moringa leaf extract with 13.40kg/ha, increased in plant height after 3 weeks of transplanting with a height of 41.02cm, 12leaves, 3.79cm stem grith and leaf area index of 17.23cm^2.

Keywords: Moringa oleifera,Foliar, Fertilizer, Celosia argeata, Leaf, Extract and Growth

Introduction
The daily human intake of synthetic residual chemicals in there dietary component taken up by field crops during fertilizer application has led to various degrees of health challenges that has results to more poisonous, incurable ailments and at times death of the consumer. The idea of organic agriculture where plant and animal origin fertilizer is now trending as a replacement for the dangerous chemicals with serious residual effects. The depletion of soil nutrients due to continuous cropping reduces the soil organic matter, cause significant acidification and yield reduction (Batiano and Makwunye, 1991; Anonymous, 1995; Ajilore, 2008). There is therefore need for adequate fertilization or manuring in order to sustain soil productivity for optimum growth and yield of planted crops to ensure food security for the ever increasing growing population. *Celosia argeanta* commonly known as plumed cocks comb or the silver cock's comb is a herbaceous plant of tropical origin and is known for its very bright colours. *Celosia argeanta* is a tender annual that is often grown in gardens. It blooms in mid-spring to summer. It is propagated by seeds. The seeds are extremely small up to 43,000 seeds per ounce. The flowers are hermaphrodites (Grant and William F., 1954). *Celosia argeanta var. argeanta* or "Lagos Spinach" is one of the main boiled green in West Africa where it is known as *Sokoyokoto*(Yoruba) or *fararalayyafo* (Hausa). (Hanelt*et al*., 2001). Organic produce are found to be of higher nutrient, minerals and healthier (Ayelagbe, 2011). Organic farming has helped in eliminating health hazard caused by residue effect of chemical fertilizers used in inorganic farming. Leaf extracts are organic fertilizers with plant origin and are alternative sources of plant nutrients that are cheaper, eco-friendly and capable of enhancing sustainable crop production. The study was carried out to evaluate effects of *Moringa oleifera* and *Gliricidia sepium* leaf extracts as foliar fertilizer on vegetative growth of *Celosia argentea,* and also provide keen knowledge on the possibility of producing *Celosia argentea* and CO in large scale with little capital and have a healthy and high yield of production with the use of various nitrogen fixer plants leaf extracts.

Methodology

The research was conducted at JABU Teaching and Research farm, Longiude9°84°64° and Latitude 10°32°73° Ilesha-Akure road, Ikeji Arakeji, Osun State. (Google Earth, 2018)). The land was manually cleared of existing vegetation and bed constructed the raised seed bed of 1.5m width by 1.5mlong and about 0.5m high were prepared using hoe and spades. The *Celosia argeantea* L.var. TLV8. seeds to be used in this study will be bought from the National Institute of Horticultural Research (NIHORT), Ibadan. The *Moringa oleifera* and *Gliricidia sepium* leaves was harvested on the teaching and research farm. 100grams of freshly harvested leaves of *Moringa oleifera and Gliricidia sepium* to 1 litres of water during the extraction.

Data Collection

The growth parameters which include height of plant, leaf index rea, number of leaves, stem diameter and weight of plant after harvest were measured at random using three replications. This was carried out every five days. The measurement of the plant and leaf index was done using a ruler which was done using a ruler which was measured in centimeters, the stem was done using vernier caliper and weight was measured using a weighing scale while the number of leaves was done by counting.

Data Analysis

Analysis of Variance (ANOVA) was used to get the mean values of plant height, leaf area index, stem diameter, number of leaves and weight after harvest three weeks after transplanting.

Results and Discussion

Table 1 shows the result obtained from the experiment 3 weeks after transplanting in same environmental conditions but different treatment.

Table 1: **Mineral Evaluation of Moringa Leaf Extract (MLE)**

Parameters	T1 (Control)	T2(Moringa Leaf Extract)	T3 (Gliricidia Leaf Extract)
Plant Height(cm)	33.90	41.02	36.00
Stem Grith(cm)	2.31	3.79	2.31
Leaf Area Index (cm2)	14.94	17.23	16.33
Number of Leaves	10.00	12.00	9.00
Stem Yield/Weight (kg/ha)	5.45	13.40	7.50

Source: Computed from field data, 2018

The result shows that Moringa leaf extract is rich in nutrient such as Potassium, Calcium, Iron and Nitrogen which enhances the vegetative growth and yield of Celosia argentea. It also leads to nutrient accumulation for increase in leaf area index and other growth parameter. This further corroborates the findings of Abdul-Rahman M. A (2017). Plant height increases weekly with respect to treatment. Table above shows Treatment 2 i.e Moringa Leaf extract had the tallest plant 3WAT(Weeks After Transplanting). Stem was significant ($p<0.05$) in all other week with progression and treatment 2 getting the highest stem grith 3WAT with 3.79cm. This corroborates the work of Aliyu and Olanrewaju (1996) on Capsicum annum where they observe that the beneficial effects of N,P and K could be seen in the increase in the increase in the stem grith, where Treatment 1 and 3 has the same value of stem grith throughout the sample periods. Treatment 2 has the highest number of leaves at three WAT with 12 leave and the Treatment 1 has the lowest numbers of leaves with 9 leaves at 3 WAT at ($p<0.05$). This corroborated the study Zhang et al (2010) who noted that Nitrogen generally stimulates vegetative growth. Olaniyi and Ojetayo (2012) and Olaniyi et al (2008) reported that *C. argentea* increases in growth with increasing rate of Nitrogenous fertilizer and vegetative cropping system requires a greater degree of management. They noted that nitrogen increases the cell size and cellular number resulting from cellular number resulting from cell division and expansion that leads to increased number of leaves and other vegetative parts of the plant. Result shows that LAI was at its peak at 3 WAT (17.23cm^2),it is significant in third WAT, with Treatment 2 with the highest leaf area index (LAI) ($P<0.05$). This implies that LAI resulting from increasing fertilizer application due to better utilization of solar radiation which favoured photosynthetic capacity of the plant. This finding corroborates the study of Law-Ogbomo and Egharevba, (2008). The table also shows that treatment 2 has the highest herbage to stem yield, with a yield of 13.40kg/ha. This agrees with the findings of Ojeniyi et al. (2009) who reported that the use of inorganic fertilizer increases the yield of crops and have been found to be effective as a short term solution which demands consistence use on a long term basis.

Conclusion

Based on the results of the experiment, it has revealed that *Celosia argentea* sprayed with *Moringa oleifera* leaf extract was better than others in the same condition. The study has shown that the cultivation of *Celosia argentea* can be possible on foliar application of organic fertilizers with plant origin depending on the vegetative plant growth to measure. Based on the results obtained, Celosia performed best on organic foliar fertilizer of plant origin. Hence, the recommended foliar fertilizer for the cultivation of the Celosia argentea is *Moringa oleifera* leaf extract and alternatively the combination of *Moringa oleifera* and *Gliricidia sepium* leaf extracts can also be used for maximum output.

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Effects of Rhizome Size on Growth and Yield of Ginger (*Ginger Officinale* Rosc) in Nsugbe, Anambra State

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Abstract
A field experiment was conducted to evaluate the effects of rhizome sizes on the growth and yield of ginger crop in 2012/2013 cropping season at the Teaching and Research Farm, Department of Agricultural Education, Nwafor Orizu College of Education, Nsugbe, Anambra State. The experiment was arranged in a randomized complete block design with three replicate and the rhizome sizes were 10g, 15g, 20g 25g and 30g. Data on growth parameters were taken at 4, 12 and 20 weeks after planting (WAP), on plant height (cm), number of leaves, number of tillers and total leaf area (cm²) while fresh rhizome weight (g), rhizome length (cm) and width (cm) were evaluated at harvest. The results showed that ginger grown from 20g rhizome size had ($P < 0.05$) higher plant height (cm), number of leaves, number of tillers and total leaf area(cm²) than those grown from other rhizome sizes. Ginger grown from 20g rhizome size had higher rhizome fresh weight (118.39g), rhizome length (12.87cm) and width (10.78cm) than ginger yield from other treatments. Therefore for optimum yield of ginger 20g of rhizome size is hereby recommended.
Keywords: Ginger, Rhizome size, Growth and Yield

Introduction
Ginger (*Zingiber officinale* Rosccoe) is monocotyledonous, herbaceous, tropical plant belonging to the family *Zingiberaceae*.. Ginger even though a native to South East Asia, now it is grown commercially in most tropical regions (Abeykera et al., 2005). The top five ginger producer countries are India, China, Nepal, Nigeria, and Thailand. India is the largest producer of ginger accounting for more than 34% of the world production in 2011 followed by China (FAO, 2013). The modified underground stem otherwise known as rhizome is used worldwide as a preservative and as well as a spice for flavoring food and food products (Jakes, 2003). Nutritionally, ginger is an important source of vitamins and minerals in its fresh and dried (powdered) forms. It is known to supply significant levels of calcium, potassium, phosphorus, magnesium, niacin and vitamin C. (Raghavan, 2007). Apart from its nutritional values and flavoring agent, ginger is among numerous herbs known for their health benefits both in traditional and modern medicines. Ginger has a long tradition of being very effective in alleviating symptoms of gastrointestinal distress thereby facilitating digestion and treating stomach upset, diarrhea, and nausea. Furthermore, modern scientific research has also revealed that ginger possesses numerous therapeutic properties including antioxidant effects, an ability to inhibit the formation of inflammatory and carcinogenic compounds, and direct anti-inflammatory effects (UMMC, 2006; Shuka and Singh, 2008; Islam et al., 2008; Ewuziem et al., 2009 and Karna et al., 2012). The fact that ginger cultivation was mostly in the Northern part of the country except at Umudike (NRCRI) who has the mandate as a research institute; it is as an important commercial spice crop in the area and has been a good source of income for farmers who grow it. Despite its remarkable uses and contribution to the livelihoods of smallholder farmers and to the economy of the country, information on different agronomic practices of ginger cultivation such as improved varieties, agronomic practices like spacing, planting date, land preparation system and propagule size are very little in the study area in spite, of the diverse agro-climatic conditions with abundance of natural resources which provide good opportunities for ginger production. Therefore in view of the above factors, the present study was conducted to find out the best

rhizome size that will give the best growth and yield of ginger. The rhizome which is the economic yield as well as the planting material ginger affects the establishment, growth and yield of the crops. The use of large size rhizomes means the loss of the commercial product whereas the use of small seed rhizome leads reduced growth and yield. Therefore, selecting the right size of planting material (length, weight and number of growing buds per seed) is a very critical factor in the cultivation of rhizomatous spices such as ginger and turmeric (Girma and Kindie, 2008). They further opined that rhizome sizes also significantly affected fresh rhizome weight, length of rhizome, number of fingers per rhizome and rhizome yield per hectare. Hailemichael and Tesfaye, 2008) in their study found out that an increase in seed rhizome size (using a rhizome seed size of 9.1 cm) will significantly increase the major growth parameters and dry rhizome yield and using large seed rhizome was also found to be economically profitable. Similarly, Monnaf et al., (2010) in their study reported that rhizome size significantly influenced all the measured parameters like plant height (37.64cm), number of leaves per plant (26.47), number of tillers per clump (15.94), weight of old mother rhizome (11.77 g) per plant, amount of primary rhizome (1971.78 g) per clump. They further stressed that the amount of secondary rhizome (129.12 g) per clump, the highest yield (135.14 g) per plant, the maximum yield (4.57 kg) per plot were produced using 30-35g of rhizome. The lowest were produced by 10-15g of rhizome attributed to larger size which emerged earlier with vigorous and rapid growth using the initial reserve food materials in it. Sengupta and Dasgupta (2011), in a study posited that variations in growth and yields are due to seed rhizome size and further stressed that plants produced from the largest rhizome size emerged earlier and showed vigorous and rapid growth using the initial reserve food materials resulting to maximum yield and yield attributes.

Materials and methods

The experiment was carried out at the Teaching and Research Farm of the Department of Agricultural Education, Nwafor Orizu College of Education, Nsugbe during the 2012/2013 cropping seasons. Nsugbe is located at latitude 06^{o}25'N and longitude 06^{o}82'E of the equator. This location lies in the tropical rain forest zone with the average annual rainfall between 1,500mm and 2000 mm .It has a bimodal, distribution with peak in July and September (NIMET, 2013). The experimental area was cleared and stumped. Hoe was use to prepare 15 beds measuring 2m x 2m, while ginger rhizomes were sown on the beds at a spacing of 20cm x 20cm at the depth of 5cm and covered with top soil. The experimental design was a randomized complete block design (RCBD) replicated three times and the treatments compromised of five rhizome sizes 10g, 15g, 20g, 25g and 30g. The plots were weeded manually three times and other agronomic practices were carried out as the need arises. Data were collected on plant height using a metric rule, number of leaves and numbers of tillers were visually counted while leaf area were measured using graphic method and multiplied by the number of leaves for total leaf area of the plant. Rhizome's fresh weights were obtained using a digital scale while length and width were measured with a ruler and venire caliper. The data obtained were subjected to analysis of variance (ANOVA) using SAS (2010) and the means showing significant difference were separated using Duncan Multiple Range Test at 5% level of probability.

Results and Discussion

The results of the effect of different rhizome sizes on plant height and number of leaves of ginger are presented in Table 1. The plant height was significantly affected by the age of ginger crop. At 4 weeks after planting (WAP), plant heights of ginger grown from rhizome sizes of 20-30g were significantly enhanced than those grown from10-15g rhizome sizes that were significantly depressed. Within a range of 12-20 WAP, 20g rhizome size was significantly higher $P<0.05$ followed by 15 and 25g while 10 and 30g were least significant in plant heights. The results of number of leaves increased significantly across the periods of sampling. Leaf production at 4WAP, was significantly higher in ginger grown from 15-25g (4.65, 4.99 and 4.54) while 10 and 30g rhizome sizes were significantly depressed (4.20 and 4.35). Within a range of 12-20 WAP, numbers of leaves were statistically higher in rhizome size of 20g (16.31 and 19.25) than other treatments that while 30g rhizome size was depressed (14.73). Rhizome size effects on growth parameters of ginger (plant height, number of leaves per plant and number of tillers per plant) is in tandem with the findings of Hailemichael and Tesfaye (2008) and Monnaf et al (2010) who reported that rhizome size significantly influenced all the measured parameters like plant height (37.64cm), number of leaves per plant (26.47) and number of tillers per clump (15.94). They further stressed that the highest yield of (135.14 g) per plant, the maximum yield (4.57 kg) per plot produced using 30-35g of rhizome and lowest produced by 10-15g of rhizome are attributed to larger size which emerged earlier with vigorous and rapid growth using the initial reserve food materials in it. The effects of different rhizome sizes on the number of tillers and total leaf area of ginger are shown in Table 2. The tiller production were statistically similar P=0.05 at 4WAP in all the treatments. At 12 WAP, tiller production were significantly depressed in ginger grown from 10g and 30g rhizome size (3.20 and 3.24) respectively, while 20g rhizome size was significantly higher P>0.05 (4.35) than other treatments. Ginger grown from 20g rhizome size was statistically higher 5.45 than other treatments that are statistically similar 4.05, 4.12, 4.15 and 4.40 as number of tillers at 20 WAP. At 4th - 20th WAP, total leaf areas of ginger planted were significantly higher in 20g rhizome size (162.43, 739.60 and 1008.20cm$^{2)}$ followed by 25g rhizome size while tiller production from 10g rhizome size were significantly depressed (130.28, 677.55 and 816.25cm^2). The variations observed among the different rhizome sizes in growth parameters are in line with the findings of Sengupta and Dasgupta (2011) who reported that variations in growth and yields are due to seed rhizome size and further stressed that plants produced from the largest rhizome size emerged earlier and showed vigorous and rapid growth using the initial reserve food materials resulting to maximum yield and yield attributes. The results of ginger yield and yield characters from different rhizome sizes are presented in Table 3. Ginger yield for crops grown from 20g rhizome size were significantly higher in rhizome fresh weight (118.39g), rhizome length (12.87cm) and width (10.78cm) than ginger yield from other treatments. Between and within rhizome fresh weight, length and width, ginger yield and yield characters were most significantly depressed on ginger grown from 10g and 30g rhizome sizes than other rhizome size. The results are in tandem with the findings of Girma and Kindie (2008) who revealed that rhizome size significantly affected fresh rhizome weight, length of rhizome, number of fingers per rhizome and rhizome yield per hectare. They further stressed that the use of large size rhizomes means the loss of the commercial product whereas the use of small seed rhizome resulted to reduced growth and yield. Hence, they advised that in selecting the right size of planting material (length, weight and number of growing buds per seed) is a very critical factor in the cultivation of rhizomatous spices such as ginger and turmeric. The results are also in agreement with Monnaf et al., (2010) who reported that rhizome size significantly resulted to the highest yield of (135.14 g) per plant, the maximum yield (4.57 kg) per plot produced using 30-35g of rhizome and lowest produced by 10-15g of rhizome are attributed to larger size which emerged earlier with vigorous and rapid growth using the initial reserve food materials in it.

Conclusion

The study has showed that different rhizome size significantly affect the growth and yield of ginger. Therefore, for fresh rhizome weight, length and width, it is recommended that ginger should be grown using 20g rhizome size than other rhizome sizes as rhizome is the economic yield as well as the planting material of ginger.

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Table1: Effects of rhizome size on plant height (cm) and number of leaves of ginger at different sampling periods in Nsugbe

Rhizome Size	**Weeks After Planting** 4		12		20	
	Plant height(cm)	**No. of leaves**	**Plant height(cm)**	**No of leaves**	**Plant height(cm)**	**No of leaves**
10g	21.03^{b}	4.20^{b}	35.93^{b}	15.57^{b}	35.50^{c}	17.84^{b}
15g	21.08^{b}	4.65^{a}	37.69^{b}	15.25^{b}	40.61^{b}	18.30^{b}
20g	22.96^{a}	4.99^{a}	39.27^{a}	16.13^{a}	42.64^{a}	19.25^{a}
25g	22.67^{a}	4.54^{a}	37.26^{b}	15.35^{b}	40.62^{b}	18.30^{b}
30g	22.55^{a}	4.35^{b}	35.20^{d}	14.73^{c}	39.51^{c}	18.25^{b}

Means with the same alphabet(s) on the same column are not significantly different at P ≥ 0.05 level of probability using DMRT.

Table 2: Effects of rhizome size on number of tillers and total leaf area of ginger at different sampling periods

	4WAP		**12WAP**		**20WAP**	
Rhizome Size	**No of Tillers**	**Total leaf area(cm)^2**	**No of Tillers**	**Total leaf area(cm)^2**	**No of Tillers**	**Total leaf area(cm)^2**
10g	1.08^{a}	130.28^{d}	3.20^{c}	677.55^{c}	4.05^{b}	816.25^{c}
15g	1.35^{a}	145.45^{b}	3.78^{b}	689.9^{b}	4.12^{b}	904.65^{b}
20g	1.42^{a}	162.43^{a}	4.35^{a}	739.6^{a}	5.45^{a}	1008.20^{a}
25g	1.19^{a}	148.41^{ab}	3.75^{b}	697.2^{ab}	4.15^{b}	927.45^{ab}
30g	1.32^{a}	131.30^{c}	3.24^{c}	628.45^{d}	4.40^{b}	812.80^{d}

Means with the same alphabet(s) on the same column are not significantly different at P ≥ 0.05 level of probability using DMRT.

Table 3: Rhizome yield and yield characteristics of ginger as influenced by rhizome size in Nsugbe

Treatments	**Rhizome Fresh Weight(g)**	**Rhizome Length (cm)**	**Rhizome Width (cm)**
10g	58.16^{d}	10.30^{c}	8.11^{c}
15g	79.17^{b}	11.21^{b}	9.48^{b}
20g	118.39^{a}	12.87^{a}	10.78^{a}
25g	93.47^{ab}	11.62^{b}	9.48^{b}
30g	69.11^{c}	11.26^{b}	8.45^{c}

Means with the same alphabet(s) on the same column are not significantly different at P ≥ 0.05 level of probability using DMRT.

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Influence of Time and Rate of Poultry Manure on Cucumber (*Cucumis sativus* L.) in Semi -Arid Environment

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Abstract
The trial was conducted to determine the influence of time and rate of poultry manure on cucumber (Cucumis sativus L.). Field experiment was carried out in the dry season of 2017 at the Teaching and Research Farm of Federal University of Dutsin-Ma, Katsina State, Nigeria. The treatments consisted of four different times of poultry manure application (T_1=two weeks before planting, T_2=one week before planting, T_3=at planting and T_4=one week after planting) and three rates of poultry manure (0, 10 and 20 t ha^{-1}) and were arranged in a randomized complete block design and replicated three times. Time of poultry manure was significant number of leaves per plant, vine length per plant, number of fruits per hectare, fruit weight per plant and fruit yield. Poultry application at two week before planting of cucumber was found to be appropriate for cucumber production in the study area. [1] was not significant on growth and yield performance of cucumber. Application of poultry manure significantly increased number of leaves per plant, vine length per plant, number of fruits per hectare, fruit weight per plant and fruit yield. Soil fertilization at 10 t ha^{-1} of poultry manure seems to be suitable for growth and yield of cucumber in this area of study. Application of 10 and 20 t ha^{-1} of poultry manure produced 167.7 and 190.9% increases in cucumber fruit yield when compared with no poultry manure application, respectively.

Introduction
Cucumber (*Cucumis sativus* L.) belongs to the family of cucurbitaceae and is one of the important fruit vegetable crops grown in Nigeria. It is grown in commercial quantity in Northern Nigeria, eaten largely in different parts of the country and enjoyed across different ethnic groups (Iyagba and Isirima, 2017). The potential uses of cucumber have made the crop to gain popularity Nigeria. It is used for various culinary purposes and plays important role in maintaining good health because of its minerals and vitamins (Yamaguchi, 2000). It is eaten raw, cooked and used as a salad. It has been reported that minerals and vitamins present in cucumber assists in building up bone and teeth, and protects the human body and promotes major metabolic processes in the body and enhances vitality and good health (Iyagba and Isirima, 2017). Cucumber has been observed to have health benefits like ability to control hypertension in human body and causes human body to escape kidney challenges when taken on regular basis (Vimala *et al.*, 1999). Despite the important of cucumber as a major source of mineral s and vitamins, the production is still is low as result of various factors which include nutrient/water deficiency (Ayotamuno *et al*., 2007). Nigerian savanna soils difficultly support worthwhile crop production without implementing soil fertility strategies of improving fertility carrying capacity through either organic or inorganic fertilizer addition (Adesoji *et al.*, 2018). Therefore, it becomes very necessary to add organic fertilizer to Savanna soils because of its capacity of leaving the soils safer and healthier than inorganic fertilizers. Also, organic manures have been reported to sustain cropping systems by better nutrient recycling and improving physical, chemical and biological properties of soil (Ojeniyi, 2000). The major target of every farmer is better yield for better income which only possible when all production factors including inputs like organic manure are applied or available at optimum levels. The input of organic manures has been a major factor for long term cropping in the tropics because of slow mineralization of organic manures enhance crop yield for a long period of time (Gambo *et al*., 2008). Timing of

when the organic manure should be applied becomes so importance so that the effect can easily be felt by cucumber plants for enhanced growth and development and consequently, improved yield. It has reported that when organic manures are properly added to soil, they can be valuable resources for enhanced production of crops (Ajari, 2003). This study was therefore designed to investigate the influence of time and rate of poultry manure on cucumber.

Materials and Methods

The study was conducted in the dry season of 2017 at the Research and Teaching Farm of Federal University Dutsin-Ma, at Badole (Longitude $07^0 29'29''$ E and Latitude $12^0 27'18''$ N) with altitude of 605 m in the Sudan savanna ecological zone of Nigeria. The treatments consisted of four different times of poultry manure application (T_1=two weeks before planting, T_2=one week before planting, T_3=at planting and T_4=one week after planting) and three rates of poultry manure (0, 10 and 20 t ha^{-1}). The treatments were arranged in a randomized complete block design with various factorial combinations and replicated three times. The gross plot size was 2m x 2m ($4m^2$) and the net plot was 1m x 2m ($2m^2$). The experimental field was harrowed and consequently watered by flooding method. The field was further harrowed to give fine tilts and prepared into raised beds (plots) of 1.5m x 2m in basin form for irrigation purpose. Poultry manure was added to various plots by thoroughly mixing the manure with soil according to the treatments at two weeks before planting. Seeds of exotic variety named PIONSETTE 44 were planted with two seeds per hole at a spacing of 50cm x 50cm on the beds at two weeks after poultry manure incorporation. The cucumber seedlings were thinned to one seedling per stand at two weeks after sowing. Nitrogen fertilizer as urea (46%N) was applied to the cucumber at 2 weeks after sowing (WAS) according to treatments. The field was irrigated twice a week using basin method. Weeds were controlled using hoe at 3 and 6WAS. Samplings on number of leaves and branches per plant were done at 4 ad 6 weeks after sowing (WAS) while number of fruits per hectare (kg), fruit weight per plant (g) and fruit yield (kg/ha) were obtained at harvest. Data collected from the observations were subjected to statistical analysis of variance (ANOVA) as described by Gomez and Gomez (1984) using SAS package version 9.0 of statistical analysis (SAS institute, 2002). The differences among treatment means were separated using Duncan's Multiple Range Test (Duncan, 1955). Effects were considered statistically significant at 5% level of probability.

Results and Discussion

Time of application of poultry manure was not significant on number of leaves of cucumber at 2WAS and 6WAS but was significantly increased at 4WAS where application of poultry manure at 1 week after planting was significantly different from application of poultry manure at 1and 2 weeks before planting on number of leaves per plant (Table 1) but at par with application of poultry manure at planting. Application of poultry manure did not significantly increase the number of leaves per plant of cucumber at 2WAS and 6WAS but significantly increased number of leaves per plant at 4WAS. Application of 10t ha-1 of poultry manure produced significantly more number of leaves than plots that received no poultry manure but was at par with plots treated with application rate of 20t ha-1 poultry manure. Time of application of poultry manure significantly increased number of branches at 4WAS but did not significantly increase number of branches per plant at 6WAS. Application of poultry manure at 2weekks before planting produced significantly more number of branches than application of poultry manure at 1week after planting but there was no significant difference between application of poultry manure at 2weeks before planting, 1week before planting and at planting at 4WAS. Application of poultry manure was not significant on number of branches at both 4WAS and 6WAS. Time of application of poultry manure significantly increased number of fruits per hectare, fruit weight per plant and fruit yield per hectare of cucumber (Table 2). Application of poultry manure at 2weeks before planting produced significantly higher number of fruits per hectare, fruit weight per plant and fruit yield than application of poultry manure at 1week after planting and also at planting on number of fruits per hectare but was statistically similar to application of poultry manure at 1week before planting and at planting for fruit weight per plant and fruit yield of cucumber. Increasing the application of poultry manure from zero (0 t ha^{-1}) to 10t ha^{-1} significantly increased the fruit weight per plant, number of fruit per hectare and fruit yield but a further increase of poultry rate from 10 t ha^{-1} to 20 t ha^{-1} produced no significant difference on both parameters. Application of poultry manure was found to give 167.7 and 190.9% increases in fruit yield over the control for 10 and 20 t ha^{-1}, respectively

Table 1: Influence of nitrogen and poultry manure on number of leaves per plant and vine length per plant cucumber at 4 and 6WAS

	No. of leaves per plant		Vine length per plant (cm)	
Treatment	**4WAS**	**6WAS**	**4WAS**	**6WAS**
Time of Application(T)				
T1:2 weeks before planting	15.04a	39.67	31.79a	165.57a
T2:1 week before planting	13.18a	38.41	28.76b	139.24b
T3: At planting	12.15ab	31.07	27.97b	132.36b
T4: 1 week after planting	10.48b	31.04	27.57b	136.08b
SE±	1.012	3.690	0.82	7.85
Poultry manure(P) T ha^{-1}				
0	8.72b	29.49	29.12	141.86ab
10	14.69a	38.75	28.17	131.01b
20	14.72a	36.89	29.77	157.07a
SE±	0.880	3.194	0.71	6.8

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT.

Table 2: Influence of time and rate of poultry manure on number of fruit per hectare, fruit weight per plant and fruit yield of cucumber

Treatment	No. of fruits hectare^{1} (kg)	Fruit weight plant^{-1} (g)	fruit yield (Kg ha^{-1})
Time of Application(T)			
T1:2 weeks before planting	71389a	532.22a	25241a
T2:1 week before planting	59378ab	414.44ab	20844ab
T3: At planting	42733bc	348.89ab	17474ab
T4: 1 week after planting	31607c	281.78b	14030b
SE±	7461.43	60.317	2916.89
Poultry manure(P) T ha^{-1}			
0	18075b	195.50b	8836b
10	64736a	472.50a	23656a
20	71019a	515.00a	25700a
SE±	6461.79	52.240	2526.10

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT.

The significant increases reported on number of leaves per plant, vine length per plant, number of fruits per hectare, fruit weight per plant and fruit yield as influenced by time of poultry application could attributed to the fact that time is needed for the decomposition and consequent mineralization of the added poultry manure. It has been reported by Adesoji (2015) that the type and quality of organic materials added to soil for nutrient improvement determines the rate of decomposition and nutrient release status of the materials. Better performance of the measured parameters of cucumber observed at two weeks before planting could have been that the time was enough to cure and speed up the decomposition process and consequent mineralization of the manure. Abdulmaliq *et al*.(2015) reported that okra growth responded positively to the application of poultry manure two weeks before planting which was attributed to the decomposition rate of poultry manure applied two weeks before planting that made nutrients available for the growing okra when needed most. Significant increases observed on number of leaves per plant and vine length of cucumber as a result of poultry application could be attributed to the capacity of poultry manure to make available the embedded nutrients especially nitrogen, phosphorus and potassium for the growth and development of the crop. This in line with the report of Okoli and Nweke (2015) where poultry manure was reported to have an ability to enhance the soil organic matter (OM) content and in turn release the plant nutrients in available form for plants to use. The marked increases on number of leaves per plant and vine length of cucumber caused by application of poultry manure could also be that the added poultry manure created a favourable soil physico-chemical environment which enhanced photosynthetic activities of the cucumber plants for increased growth and development. Similarly, Hamma *et al*. (2012), Nweke *et al*. (2014) and Okoli and Nweke (2015) reported that application of poultry manure increased growth of cucumber. The significant increases observed on number of fruit per hectare and fruit weight per plant after fertilization with poultry manure could be attributed to the positive influence of poultry manure on number of leaves per plant and vine length per plant which culminated in significant increases observed on these yield components. Khan *et al*. (2017) reported a significant increase of average fruit weight of cucumber which was attributed to the high concentration of nutrients in high poultry manure level which boost up the growth and yield. It was equally reported that significant increase on number of fruits per plant by Khan *et al*. (2017) was due to Poultry manure ability to improve plant nutrient availability, bulk density and water holding capacity of the soil which in turn increased the vegetative growth, accelerated the division of meristematic tissue and metabolic reactions and caused plants to take more nutrients which increased the number of fruits per plant. Significant increase observed on cucumber fruit yield of cucumber after fertilization with poultry manure could be attributed to the increases observed on growth and yield components which culminated into better fruit yield of cucumber. The significant cucumber fruit yield after application of poultry manure could also be as a result of the capacity of poultry manure to improve biological, physical and chemical properties of soil, which might have created safe and healthy soil for better growth and development of cucumber plants which culminated in marked increase observed on fruit yield of cucumber. Similar fruit yield increase as a result of poultry manure application was observed by Hamma *et al*. (2012), Nweke *et al*. (2014), Okoli and Nweke (2015) and Khan *et al*. (2017).

Conclusion

Based on the results obtained from this study, conclusion can be drawn that time of poultry manure had significant effect on number of leaves per plant, vine length per plant, number of fruits per hectare, fruit weight per plant and fruit yield of cucumber where application of poultry manure at two weeks before planting was found most suitable time to apply poultry manure for cucumber production. Poultry manure fertilization at the rates of 10 and 20 t ha^{-1} exerted significant influence on growth and yield performance of cucumber. Application of 10 t ha^{-1} of poultry manure seems to be appropriate for the cucumber production in Sudan savanna ecological zone of Nigeria.

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Growth and Yield of Onion (*Allium cepa* L.) as Influenced by Intra-Row Spacing and Time of Harvesting

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Abstract
The field experiment was carried out during the 2013 dry season at the College Farm of Federal College of Forestry Mechanization, Afaka-Kaduna located at latitude 10⁰37'N, longitude 07⁰21'E elevation of 644m above the sea level in the northern guinea savannah agro-ecological zone to evaluate the effect of intra-row spacing and the time of harvesting on onion production. The treatments consist of three intra-row spacing of 10cm, 20cm, 30cm and two harvesting time of 77days, 107days respectively and a control (92days) as farmers practice, was laid out in Randomize Complete Block Design (RCBD) and replicated three times. The growth parameters observed are plant height and number of leaves at 7, 9 and 11WAT, while yield parameters are number of bulbs/plant, bulb/plot, weight of fresh bulb/plant and weight of fresh bulb/plot. The intra-row spacing of 30cm and harvesting at 77days gave significantly higher plant height while intra-row spacing of 10cm and 20cm and harvesting at 77days produced more number of leaves and number of bulbs/plot. The results obtained show that the treatments had significant effect on the characters measured. Therefore, for maximum growth and yield of onion production intra-row spacing of 20 cm and harvesting at 77 days should be recommended and adopted in the study area.
Keywords: Onion, Spacing and harvest time

Introduction
Onion (*Alliun cepa* (L) belongs to the family *Alliaceae* and is of immense benefit due to its diet and medicinal values. Onion is one of the most important vegetable crops in Nigeria, where it is exported and is an important condiment in the preparation of curry and spicy dishes, the crop is grown for consumption both in the green state as well as in mature bulb (FAO, 2005). Onion is one of the oldest food sources in the world. Onion is popularly called 'Albassa' in northen Nigeria; it is grown under irrigation with low humidity. Onion exhibits particular diversity in the eastern Mediterranean countries, through Turkmania, Tajikistan to Pakistan and India, which are the most important sources of genetic diversity and believed to be the center of origin (Brewester, 2008). The total area under production of onion in Nigeria is estimated at 0.1- 0.2 million hectares (Dantata, 2008). In Africa, the leading countries are Niger Republic with 36 tons/ha, Egypt 30.5 tons/ha, South Africa 26 tons/ha and Morocco 24.9 tons /ha (FAOSTAT, 2013). Despite the ranking of onion as the second most important vegetable in Nigeria, the present production level does not meet the demand of the teeming populace. Though, the consumption of onion cuts across the country, its production is limited to the northern part of the country, restricted to fadama areas, and grown mostly during the dry season under irrigation. Nigeria is leading in onion production in West Africa with 0.615 million metric tons of dry bulb (FAOSTAT, 2013) but the consumption rate did not meet the continuous market demand; this could be as a result of its nutritional value and medicinal uses. It can be easily assumed that there is always shortage of onion in Nigeria and this is due to improper agronomy practices. Successful onion production depends upon the identification of appropriate agro-techniques that will promote growth, development and bulb production satisfactorily. Varying the spacing between plants has been found to have a great influence on growth and development of the crop, such exploitation can be accomplished when population density of a crop exercise maximizes pressure on all production, such as solar radiation, soil nutrient and water (Khan *et al.,* (2002). Agronomic

practices are the best that will attain the correct amount of food for maximum growth and production; this is usually achieved by using correct intra-row spacing. Khan *et al.* (2002) stated that a uniform distribution of plant per unit area is a perquisite for yield stability. Khan *et al.* (2002) observed that wider plant spacing in onion, resulted in heavier bulb production, they also stated that wider plant spacing would also increase bulb diameter of onion. Delaying in harvesting of onion till after the fall or top down of 80% of leaves resulted in increases in the rate of storage rot. However, result on yield tends to show that early and late harvest lead sprouting, rotting and later to loss in quality of yield (Khan *et al.,* 2002). Therefore, the optimal time of harvest for maximum yield of onion is necessary. In view of these, the trial thus examined the response of onion to intra-row spacing and harvest time with the aim of recommending the most appropriate spacing and harvesting time for the sustainability, vigorous growth and yield in the study area.

Materials and Methods

The experiment was carried out during late 2013 to early 2013 dry season at the Federal College of Forestry Mechanization Afaka, Kaduna experimental site $10^{0}37^{'}$, $07^{0}21$'E and 644m above sea level in the Northern Guinea Savanah agro-ecological zone. The treatments consist of three intra-row spacing 10, 20 and 30cm and two harvesting time, 77 and 107 days and a central of 92 days (Farmers practice) which was arranged in factorial combination. The treatments were laid out in Randomized Complete Block Design (RCBD) replicated three times to give a total of eighteen treatments. A seed of (COMPR4) were used as a test crop and was sourced from the Institute for Agricultural Research, ABU Samaru, Zaria. Nursery beds of 2m x 2m were marked out and cleared. Organic manure (poultry) was incorporated and watered for two weeks before planting. Seeds were drilled into rows of 15cm apart to raise onion seedlings on 8th December 2013. Regular watering was carried out by means of watering can and hand-pulling of grasses until the seedlings were ready for transplanting at the area for 8 WAS. The nursery beds were thatched with dry grass as mulch in order to provide shade for the seeds before germination and prevent loss of soil nutrients. Prior to land preparation, composite soil samples were collected at five different locations within the farm at the depth of 0-15 cm and 13-30cm using soil auger and the soil was subjected to laboratory analysis for physical and chemical properties of the soil. At eight (8) WAS healthy and vigorous seedlings were selected from the nursery. The seedlings were removed carefully with the ball of earth to avoid damage to the root. The sunken beds were prepared and watered before transplanting. The size of the bed was 2m x 1.5m = ($3m^2$). The field was marked out into plots and thereafter leveled. Transplanting was carried out on 8th February, 2013 with one seedling per hole at a depth of 5cm, with spacing of 10 x 2 cm, 20 x 2 cm and 30 x 2cm, respectively. Agronomic practices such as irrigation, fertilizer application, weeding, pests and disease control were properly observed. Harvesting was carried out according to the treatments 77, 92 and 107 days after transplanting. During this time 50 – 80% of the leaves fall over and it was carried out using handing pulling. Four plants were tagged within a plot for data collection. Data were collected on plant height, number of leaves/plant, crop vigor score, number of bulb/plant, number of bulb/plot, weight of bulb/plant and weight of bulb/plot. Plant height was taken using meter rule to measure the centre of leaf from soil level to the top of the leaf, while number of leaves was obtained by counting the number of leaves from the topped plant and average computed at 7, 9 and 11 WAT. The crop vigor score was taken at 4, 9, and 11 WAS using a scale of 1 to 9 where 1 represented dead plant and 9 represented the most vigorous plant. Number of bulbs/plant was taken by counting the number of bulbs in each uprooted tagged bulb during harvesting and average computed. Weight of the bulb/plant and bulb/plot was obtained by using measuring scale graduated in gram (g) to measure the weight and average computed. The data obtained were subjected to Analysis of Variance (ANOVA). Mean separation was done at 5% level of probability using Duncan Multiple Range Test (DMRT) as suggested by Duncan, (1955).

Results and Discussion

Table 1 shows the effect of intra-row spacing and time of harvest of onion on plant height, crop vigor and number of leaves/plant at 7, 9 and 11 weeks after transplanting (WAT) during 2013 dry season at Afaka. The results obtained show that there was no significant difference on intra-row spacing at 7 WAT but significant at 9 and 11 WAT on crop vigor and number of leaves/plant. Intra-row spacing 10cm, 10 and 20cm gave higher crop vigor of (9.78) and produced more number of leaves/plant (62.44) while the least were obtained at 20cm of 3.67 and 30cm of (41.33) respectively. However, harvesting time of 77 days gave higher crop vigor of (9.67) and more number of leaves/plant of (57.44) while the least were obtained from 107 days of (4.78) and (31.56). Significant interaction was observed at intra-row spacing at 30cm and 77 days of harvest time. Table 1 shows the effect of intra-row spacing and time of harvest of onion on number of bulb/plant, bulb/plot, weight of bulb/plant and bulb/plot during 2013 dry season at Afaka. The result obtained shows that there was no significant difference on number of bulb/plant and bulb/plot but significance on number of bulb/plot. Intra-row spacing of 30cm produced more number of bulb/plant of (1.42) and spacing at 10cm produced number bulb/plot of (56.33). The least number of bulb/plant and bulb/plot was produced by spacing at 10cm of (1.00) and 50cm of (19.11) respectively. However, there was no significant difference on harvest time on number of bulb/plant and bulb/plot. Harvesting time of 92 days produced more number of bulb/plant and bulb/plot of 1.53 and 35.78 while the least was produced at 77 days of (1.00) and (33.89). No significant interaction was observed. There was significant difference on weight of bulb/plot. Intra-row spacing at 30cm gave heavier bulb/plant and bulb/plot of (326.58) and (2000.1g) while spacing at 10cm gave the least of (250.5/g) and (1000.72g) respectively. However, there was no significant difference on time of harvest on weight of bulb/plant/plot. Harvest time of 92 days gave heavier bulb/plant and bulb/plot of 35.78 and 77 days had heavier bulb/plot (2000.7g). The least weight bulb/plant was obtained from 77 days of 33.89g and 107 days of (1000.16g). No significant interaction was observed. The higher growth and yield of onion obtained during the trial 2013 dry season was due to the relatively moderate climatic weather condition during the time when the experiment was conducted. The higher number of leaves/plant of (62.44) obtained in plant with 30cm and 20cm spaced followed by plant with 10cm planting spaced (41.33) per plant respectively, shows non-significant behavior during growing period of 5 and 7 WAT but significant at 9 and 11WAT which may be as a result of environment factor and heterogeneous nature of soil. The intra-row spacing of 10cm gave the minimum number of leaves/plant (41.33). This might be due to competition among the plants to achieve the required food for their growth due to the closer spacing. The result obtained is in agreement with Khan *et al.* (2002) who reported that closed plant spacing produced minimum number of leave in plant, due to higher competition between the plants. Significantly maximum bulb weight (326.58g) was recorded in plant spaced at 30cm apart followed by 20cm plant spacing with (293.29g). Production of heavier bulb at wider spacing might be attributed to the fact that, plants widely spaced experienced less or little competition for limited environmental resources compared to closely spaced plants. Similar result was reported by Balraj *et al.* (1998); Khan *et al.* (2002) who observed that wider plant spacing in onion resulted in heavier bulb production. Intra-row spacing also affected the bulb yield/plot, the data obtained shows that maximum bulb yield/plot of (56.33kg) was recorded in plants with closer spacing of 10cm, followed by plants spaced at 20cm and 30cm producing average yield of (29.67kg) and (19.11kg) per plant, respectively. On the other hand close spacing may produce higher yield but the quality of produce may be adversely affected and may not attract better market (Singh, 1984).

Conclusion

The result obtained from the trial shows that intra-row spacing of 20cm and harvest time of 77 days gave higher plant height, produced more number of bulb/plant/plot and heavier weight of bulb/plant/plot than all other treatments on the character measured. Based on the finding, for maximum growth and yield of onion, intra-row spacing 20cm and harvest time of 77 days may be recommended in the study area. For a good growth and yield of onion (*Allium cepa* L.) production during dry season, intra-row spacing at 20cm and harvest time of 77 days could be adequate for maximum production of onion in the study area. Therefore, for maximum growth and yield of onion intra-row spacing at 20cm and harvest time of 77 days may be adopted, and recommended in the study area.

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Table 1: Effect of intra-row spacing and time of harvest on the growth and yield of onion at Afaka in 2013 dry season

Treatments	Plant height (cm)			Number of leaves plant^{-1}			Crop vigor score plant^{-1}			Number of bulbs plant^{-1}	Number of bulbs plot^{-1}	Weight of bulbs plant^{-1} (g)	Weight of bulbs plot^{-1} (kg)
Intra-row spacing (cm)	7	9	11	7	9	11	7	9	11				
10	64.67	71.98	88.20	30.89	39.11a	41.33b	7.98	7.44a	5.78a	1.00	56.33a	250.51c	1.72
20	66.26	74.46	96.92	34.11	35.00b	62.44a	9.11	5.78b	3.67c	1.11	29.67b	293.29b	1.81
30	70.49	76.29	102.31	33.11	34.78c	62.44a	9.22	5.55c	4.89b	1.42	19.11c	326.58a	2.17
SE+	1.619	1.823	1.336	0.359	1.007	2.986	0.093	0.192	0.286	0.051	0.916	11.203	0.089
Harvesting time (days)													
77	73.00	82.32	98.93	34.33a	38.00	57.44a	9.67	6.67	4.78	1.00	33.89	33.89	2.17
92	66.54	75.20	97.97	33.00ab	39.33	50.11ab	9.11	6.22	4.78	1.53	35.78	35.78	1.93
107	61.89	63.20	90.63	30.89b	31.56	36.44c	9.33	5.89	4.78	1.00	35.44	35.44	1.60
SE+	1.619	1.823	1.336	0.359	1.007	2.986	0.793	0.192	0.286	0.051	0.917	0.917	0.089
Interaction													
10 x 77	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
10 x 92	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
10 x 107	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
20 x 77	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
20 x 92	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
20 x 107	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
30 x 77	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
30 x 92	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
30 x 107	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means with the same letter (s) within a column are not significantly different at 5% level of probability (DMRT)**,** NS = Not significant at 5%**,**
KEY: - cm = centimeters, g = grams, kg = kilograms,

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Yield and Yield Components of Roselle (*Hibiscus sabdariffa* L.) as affected by Inorganic Fertilizer Application Levels and Pruning Periods

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Abstract
The experiment was conducted during 2013 rainy season at the school farm of Federal College of Forestry Mechanization, Afaka-Kaduna, located at latitude 10⁰37'N, longitude 07⁰21'E and elevation of 644m above sea level in the Northern Guinea Savanna agro-ecological zone to determine the effects of inorganic fertilizer application levels and pruning periods on yield and yield components of roselle (Hibiscus sabdariffa L.). The treatments comprised of two levels of inorganic fertilizer application (NPK 20:10:10) 30kg/ha and 60kg/ha, two pruning periods (eight (8) and ten (10) week after planting) and control (unpruned) farmers practices which was arranged in factorial combination laid out in Randomized Complete Block Design (RCBD) and replicated four times. The parameters taken include number of calyx/plant, calyx weight/plant, calyx weight/plot, calyx yield kg/ha, number of seeds/capsule and 100 seed weight. The result obtained showed significant difference on number of calyx/plant, weight of calyx/plant, weight of calyx/plot, weight of calyx kg/ha. Therefore, application of inorganic fertilizer levels at 60kg/ha and pruning period at eight (8) weeks after planting (WAP) manifested significantly higher effects on yield and yield components of Roselle and should be recommended and adopted for use in the study areas.
Keywords: Roselle, fertilizer application and pruning period

Introduction
Roselle (*Hibiscus sabdariffa L.*) is a species of *Hibiscus* native to the West Africa and it is known in different countries by various common names sorrel, karkade, jamaica, rosella, zoborodo, isapa, pupa. It belongs to the family of *Malvaceae* commonly known as "Karkade" (Maunde, 2010). *Hibiscus sabdariffa L.* probably originates from Africa, where it may have been domesticated in Sudan about 6000 years ago, first for its seed and later for leaf and calyx production. The selection for fibre production took place in Asia, where cultivation was reported from the beginning of the 20th century, for example in India, Sri Lanka, Thailand, Malaysia and Java (Babajide *et al.,* 2004). In tropical Africa, it is common in the Savanna regions of the West African, it is often found as an escape from cultivation. However, apparently truly wild plant of *Hibiscus sabdariffa L*. has been collected in Ghana, Nigerian and Angola (Maunde, 2010).
Despite the numerous importance of roselle, the production in Nigeria is still low; this might be as a result of the fact that production is limited to small holding under subsistence practices. Roselle is grown predominately in savanna where there is low inherent low fertility of the soil this result to low productivity of crops. This trial thus investigated the response of roselle to different levels of inorganic fertilizer and pruning periods, with the aim of recommending the most appropriate level of fertilizer requirement and pruning period on yield and yield component of rosselle in the Northern guinea savannah ecological zone of Nigeria.

Materials and Methods
The field trial was conducted during 2013 raining season at the Federal College of Forestry Mechanization Afaka, Igabi Local Government Area of Kaduna state. The experimental farm site is

located at latitude 10 37N & Longitude 7 47E and 644m above sea level situated in the Northern guinea savannah ecological zone of Nigeria. The experimental comprised of two level of inorganic fertilizer application 30 and 60 kg/ha, two pruning periods eight (8) and ten (10) weeks after planting and a control unpruned (farmers practiced). This was arranged in factorial combination and laid out in Randomized Complete Block Design (RCBD) and replicated four times. Prior to land preparation, composite soil samples were collected at five different locations within the farm at the depth 0-30cm using soil auger and the soil was subjected to laboratory analysis for physical and chemical properties of the soil. The meteorological report were obtained from federal Airport authority Kaduna as shown in appendices i and ii respectively. The seeds were sourced from Institute for Agricultural Research, Samaru, Zaria and the variety used was local. It is of medium height with a profuse branching habit with dark stems, petiole and midribs. The local variety product is high quality calyx preferred by consumers and marketers. The seeds were dressed with Apron plus at the rate of 5g per 2kg seeds before planting to protect them from soil borne, pest and diseases. The experimental site was cleared, harrowed twice and ridged at 75cm spacing. The gross plot size was 3.8m x 2.5m (9.5m^2) consisting of six ridges, 2,5m long, spaced 0.75m apart and 1m between the replication and plot. The net plot was 2.3m x 1.5m (3.5 m^2) which made up of four ridges. The seeds were planted 26th July, 2013 manually using hand at the spaced of 50cm x 75cm. Six seeds were planted per hill on a depth of 3-4 cm which was later thinned to two plants per stand at two weeks after planting. Inorganic fertilizer (NPK) 20: 10: 10 was applied in two split doses at two and seven weeks after planting according to the treatments. Pruning of the main stems was carried out at 8 and 10 WAS using razor blade according to the treatments. Weeding was carried out at 3, 6 and 9 WAP using manual hoe-weeding, pest and diseases were monitored and controlled using insecticide Uppercut 500EC (Lambdacyhalothrin) at the rate of 25 ml per 15 litres of water poured into CP-15 knapsack sprayer and sprayed commenced from two weeks after planting as a routine preventive measure against pests and diseases. Harvesting commenced on 29th November 2013 manually using sharp knife during this time the calyx were fully matured. The plant reached full physiological maturity at sixteen weeks after planting and ready for harvest when the lower leaves have been shedded and lower capsules on the stem were about to split. Seeds turned reddish brown and capsules were about to open. The calyx was separated from the capsule, air dried and then the capsule was shelled to obtain the seeds. A destructive sample of five plants was taken at random from the four inner rows of experimental plot at maturity to measure yield and yield components. Observations were carried out on number of calyx and were obtained by counting total number of harvested calyx from five randomly selected plants in each plot and average computed. Calyx's dry weight/plant this was obtained by peeling off the calyx from the capsule of five selected plants using simple hand tools. The calyx were air dried to constant weight, using Denver electronic digital scale model XP 300 weighing at 0.01g precision and then average calyx yield per plant (g) was determined. Calyx dry weight /plot, harvested calyx from each plot was air-dried removed from capsule and weighed. The mean average computed. Calyx yield kg/ha**,** the yield per plot weighed was later converted to per hectare basis using this formula.

$$\text{Calyx yield kg/ha} = \frac{\text{calyx yield kg/plot x } 10{,}000\text{m}^2}{\text{Harvested plot area m}^2}$$

Number of seeds/capsule; ten (10) capsules were randomly selected from tagged plant in each plot and the seeds were shelled from capsule, seeds counted and mean recorded. Seed weight/plant; the number of seeds /capsule obtained were weighed and mean weight computed. 100 seed weight, this was determined by randomly selected 100 seeds from number of seed/plot from each plot, weighing and the means recorded. The data obtained were subjected to Analysis of Variance (ANOVA). Mean separation was done at 5% level of probabilities using Duncan Multiple Range Test (DMRT) (Duncan, 1955).

Results and Discussion

The effect of different levels of inorganic fertilizer and pruning periods of roselle (*Hibiscus sabdariffa* L.) on number of calyx per plant, weight of calyx/plant, weight of calyx/plot and weight of calyx kg/ha is presented in (Table 1). The result obtained revealed there were significant differences on the parameters measured. However, application of inorganic fertilizer at 60kg/ha produced more number and heavier fruit weight than 30kg/ha. Pruning period at 8WAP gave more numbers of calyx while unpruned produced the least. Table 2 shows the effect of different levels of inorganic fertilizer and pruning period of roselle on number of seeds per capsule, weight of seed/capsule and 100 seed weight. The results obtained shows there was significant differences on number of seed/capsule and 100 seed weight. However, application of inorganic fertilizer at 60kg/ha produced more number and heavier weight of seed per capsule. Pruning periods at 8WAP gave more and heavier seed while unprunned gave the least. The significant response of roselle to the application of inorganic fertilizer in this trail explained the importance of the nutrients to yield and yield component of the crop. Number of calyx and calyx weight increased with increases in fertilizer level. This could be attributed to the fact that application of inorganic fertilizer supplied enough nutrients required by plant for vigour growth. The application of 60kg/ha of inorganic fertilizer produced number of calyx/plant and seed/capsule, heavier fruit weight/plant/plot, 100 seed yield and seed weight/capsule than 30kg/ha (Okunsaya *et al.,* (1999). Babajide *et al.* (2007) who observed increased in calyx yield as a result of inorganic fertilizer application, which was attributed to increase in crop photosynthetic ability, as a result of good vegetative growth induced by this treatment. Maunde (2010) reported that application of 60kgNPK, significantly increased number of calyx, and seed yield of roselle. Also, Halimatul *et al.,* (2007) who reported that inorganic fertilizer has positive influence on the yield components of roselle and this could be attributed to the direct effect of nitrogen on meristematic and photosynthetic activities, and partitioning of assimilates to the reproductive sink. Pruning periods at 8 and 10 weeks after planting produced more number of calyx/plant and seed/capsule, heavier weight calyx/plant/plot and seed yield/capsule than unpruned, this was as a result pruning creates more surface area for development of branches and calyx than on pruning.

Conclusion

The results obtained from the trial shows that 60kg/ha of inorganic fertilizer application and pruning at eight weeks after planting gave more numbers of calyx/plant, heavier weight of calyx/plant, weight of calyx/plot, weight of calyx/ha than all the other treatments. The least of roselle was obtained from the unpruned. For good yield and yield component of roselle (*Hibiscus sabdariffa* L.) production during rainy season, application of inorganic fertilizer of 60kg/ha and pruning period at eight weeks after planting could be adequate for maximum production of roselle in the study area. Therefore, for maximum yield of roselle production, application of 60kg/ha of NPK 20:10:10 fertilizer with pruning period at eight weeks after planning may be adopted and recommended in the study area.

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Table 1: Effect of different levels of inorganic fertilizer and pruning period on number of calyx/plant, weight of calyx/plant, weight of calyx/plot and weight of calyx in kg/ha during 2013 rainy season at Afaka

Treatments Fertilizer Level kg/ha	**No of calyx/plant**	**Weight of Calyx/plant**	**Weight of Calyx/plot**	**Weight of calyx kg/ha.**
60	122.80a	98.76a	1048.92a	1.101a
30	82.0b	71.80b	776.00b	0.817b
SE±	0.91	0.66	5.65	0.006
Pruning Period (WAP)				
Pruned at 8	112.33a	96.33a	1012.75a	1.079a
Pruned at 10	108.92a	89.02a	950.13a	0.985b
Unpruned	85.97b	70.50b	774.50b	0.813c
SE±	1.37	1.00	8.48	0.009
Interaction				
60 x 8	*	*	*	*
60 x 10	NS	NS	NS	NS
60 x unpruned	NS	NS	NS	NS
30 x 8	NS	NS	NS	NS
30 x 10	NS	NS	NS	NS
30 x unpruned	NS	NS	NS	NS

Table 2: Effect of different levels of inorganic fertilizer and pruning periods on number of seeds/capsule, weight of seeds/capsule and 100 seed weight during 2013 rainy season at Afaka

Treatments Fertilizer Level kg/ha	No. of seeds/capsule	Weight of seeds/capsule (g)	100 seed weight (g).
60	29.52	0.036a	3.96a
30	27.27b	0.031b	3.49b
SE±	0.07	0.0003	0.03
Pruning Period (WAP)			
Pruned at 8	28.80a	0.033	3.88
Pruned at 10	28.53ab	0.035	3.75
Unpruned	27.85b	0.033	3.55
SE±	0.10	0.0005	0.04
Interaction			
60 x 8	NS	NS	NS
60 x 10	NS	NS	NS
60 x unpruned	NS	NS	NS
30 x 8	NS	NS	NS
30 x 10	NS	NS	NS
30 x unpruned	NS	NS	NS

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Effects of Mulch and Organic Manure on the Growth and Yield of Sweet Melon (*Cucumis melo* L.) at Dadinkowa

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Abstract

A study was conducted during the 20132014 dry season to determine the effects of mulch and organic manure on the growth and yield of sweet melon at the Teaching and Research Farm of Federal College of Horticulture, Dadinkowa in the sudan savannah ecological zone of Nigeria. Results indicated that dry rice straw and poultry manure affected growth and yield traits such as vine length, number of leaves plant^{-1}, fresh fruit yield plot^{-1} and fresh fruit yield hectare^{-1} than the other applications. There was no significant effect due to mulch and organic manure on number of vines plant^{-1} and number of fresh fruits plant^{-1}. The effects of dry rice straw mulch and poultry manure application produced significantly higher means of the characters assessed compared to the rest of the treatments; whereas the control treatments of no mulch and no organic manure significantly produced the lowest means of the same traits studied.

Keywords: Sweet melon, mulch, organic manure, growth and yield

Introduction

Melon (*Cucumis melo* L.) belongs to the family Curcubitaceae and originated from the Middle East to the Mediterranean regions (Nkansah *et al.*, 2012). Melon production worldwide in 2009 was 31,053,716 tons, 0.33% more than the 30, 953, 684 tons in 2008 (Nkansah *et al.*, 2012). FAO (2009) reported that melon production in the world was realized from 1.3 million hectares of land. In the same year, melon production in the world was 26.70 million tons (FAO, 2009). China is the leading Country in production about 51% followed by Turkey with 6%, USA and Spain each with 4% (FAO, 2009). Melons are consumed as deserts, fresh cut-fruits and juices (Nkansah *et al.*, 2012). The relishing pulp which is highly nutritional, sweet pleasant aroma, light color, firm flesh texture, high sugar content above 10% and proper shape traits which make melon unique and a relish in the world (Aguyoh *et al.*, 2010). Vegetable production is getting an increase all round the world. Nigeria has favorable ecological conditions for vegetable growth and is one of the most important vegetable producers in the world. Turkey is fourth important producer (25.3 million tons) country regarding of vegetable production in the world. Vegetables commonly grown in Nigeria today consist of annual crops including Solanaceous, Cucurbits, Bulbs, Legumes and other indigenous vegetable species. In terms of economic value, nutrition, consumers preference, general adaptability and extent of cultivation the most commonly grown vegetable crops are tomato, watermelon, cucumber, pepper (hot and sweet), eggplant, onion, melon etc (Oyewole *et al.*, 2012). Melon is one of the most important vegetable in Nigeria (Oyewole *et al.*, 2012). To increase vegetable production, many applications such as mulch and organic manure are applied in different environmental conditions (Nwangburuka *et al.*, 2013). Mulching and organic manure in vegetables can increase yields, promote early harvest and reduce fruit defects (Gordon *et al.*, 2010). This study was conducted to determine the effects of mulch and organic manure on the growth and yield of sweet melon at Dadinkowa.

Materials and Methods

The experiment was conducted during the 2013/2014 dry season at the Teaching and Research Farm of Federal College of Horticulture, Dadinkowa in the sudan savannah ecological zone of Nigeria. The trial was laid out in a split plot design with no mulch (control), black plastic mulch, white plastic mulch and dry rice straw mulch assigned as main plot treatments, whereas organic manure source of no manure (control), goat manure, cow dung and poultry manure assigned as sub plot treatments, replicated three times. Seeds of sweet melon were sown at the beginning of the dry season into multiple trays having growing medium during the 2013 dry season. Beds of 3 x 2 m were prepared 1 m apart from each other. Black plastic mulch, white plastic mulch and dry rice straw mulch were laid down on the beds and holes were opened at 1 m x 1 m for planting seedlings, except the control where no mulch was applied. Seedlings were planted first week of January in 2013 dry season. The required cultural practices were made during the growing period. Parameters such as vine length, number of leaves plant^{-1}, number of vines plant^{-1}, number of fresh fruits plant^{-1}, fresh fruit yield plot^{-1} and fresh fruit yield hectare^{-1} were recorded. Data were tested by analysis of variance and treatments were compared using Duncan's multiple range test (Rangaswamy, 2010).

Results and Discussion

Table 1 shows that the physical properties of the soil in 2013 dry season was sandy-loam with high proportion of sand (86.88%), low silt (7.42%) and clay (11.24%). The chemical analysis revealed that the soil contains low amount of organic carbon (5.44%), pH in water (6.52), total nitrogen (3.56%), total phosphorus (2.24 mg kg^{-1}), potassium (1.58 mg kg^{-1}), magnesium (0.58 mg kg^{-1}), sodium (0.53 mg kg^{-1}) calcium (1.35 mg kg^{-1}) and cation exchange capacity (CEC) (5.23 mg kg^{-1}).

Vine length (cm)

Table 2 shows a significant difference at $P \leq 0.05$ between means due to mulch at 4WAS, 8WAS and 12WAS during the 2013 dry season. The control of no mulch applied significantly produced the lowest means of 12.47, 14.55, and 25.34 on vine length; whereas dry rice straw significantly produced the highest means of 17.36, 25.46 and 28.47 throughout the sampling periods on plant height. Table 2 also shows a significant difference at $P \leq 0.05$ between means due to organic manure at 4WAS, 8WAS and 12WAS during the 2013 dry season. The control of no manure applied significantly produced the lowest means of 12.48, 14.56, and 25.36 on vine length; whereas poultry manure significantly produced the highest means of 17.40, 25.48 and 28.49 throughout the sampling periods on vine length of sweet melon.

Number of leaves plant^{-1}

Table 2 shows a significant difference at $P \leq 0.05$ between means due to mulch at 4WAS, 8WAS and 12WAS during the 2013dry season. The control of no mulch applied significantly produced the lowest means of 8.43, 10.58 and 17.32 on number of leaves plant^{-1}; whereas dry rice straw significantly produced the highest means of 12.46, 14.76 and 22.43 throughout the sampling periods on number of leaves plant^{-1}. Table 2 also shows a significant difference at $P \leq 0.05$ between means due to organic manure at 4WAS, 8WAS and 12WAS during the 2013 dry season. The control of no manure applied significantly produced the lowest means of 8.45, 10.61 and 17.34 on number of leaves plant^{-1}; whereas poultry manure significantly produced the highest means of 12.48, 14.78 and 22.46 throughout the sampling periods on number of leaves plant^{-1}.

Number of vines plant^{-1}

Table 2 shows a no significant difference at $P \geq 0.05$ between means due to mulch and organic manure at 4WAS and 8WAS and 12WAS during the 2013 dry season on number of vines plant^{-1}.

Number of fresh fruits plant^{-1}

Table 3 shows a no significant difference at $P \leq 0.05$ between means due to mulch and organic manure at 10WAS, 12WAS and 14WAS during the 2013 dry season on number of fresh fruits plant^{-1}.

Fresh fruit yield (kg) plot^{-1}

Table 3 shows a significant difference at P≤0.05 between means due to mulch during the 2013 dry season on fresh fruit yield plot^{-1}. The control of no mulch applied significantly produced the lowest mean of 3.54 on fresh fruit yield plot^{-1}; whereas dry rice straw significantly produced the highest mean of 5.36 during the sampling period on fresh fruit yield plot^{-1}. Table 3 shows a significant difference at P≤0.05 between means due to organic manure during the 2013 dry season on fresh fruit yield plot^{-1}. The control of no manure applied significantly produced the lowest mean of 3.51 on fresh fruit yield plot^{-1}; whereas poultry manure significantly produced the highest mean a of 5.31 during the sampling period on fresh fruit yield plot^{-1}.

Fresh fruit yield (tons) hactare^{-1}

Table 3 shows a significant difference at P≤0.05 between means due to mulch during the 2013 dry season on fresh fruit yield plot^{-1}. The control of no mulch applied significantly produced the lowest mean of 3.84 on fresh fruit yield plot^{-1}; whereas dry rice straw significantly produced the highest mean of 4.62 during the sampling period on fresh fruit yield plot^{-1}. Table 3 shows a significant difference at P≤0.05 between means due to organic manure during the 2013 dry season on fresh fruit yield plot^{-1}. The control of no manure applied significantly produced the lowest mean of 3.68 on fresh fruit yield plot^{-1}; whereas poultry manure significantly produced the highest mean a of 4.84 during the sampling period on fresh fruit yield plot^{-1}.

Mulch applications significantly increased plant growth and yield in the experiment. The highest plant growth and yield was obtained from dry rice straw application; whereas the lowest plant growth and yield from the control of no mulch applied. Similar results were reported by Nkansah *et al.* (2012); Aguyoh *et al.* (2010); Gordon (2006). Gordon (2006) recorded that row covers with plastic mulch resulted in increased soil temperatures but had no effect on the yield of muskmelon. In Louisiana, row covers with plastic mulch were credited with increased soil temperatures. The increased soil temperatures were beneficial in producing a greater total yield of a watermelon crop. James (2013) reported similar observation that one important attribute to any organic mulch is its nutrient content. Organic mulch improves the soil over the long term and increases the fertility of soil at a given site. Such mulching methods may actually be preferred in organic farming as a means to increase soil organic matter content, improve long-term soil fertility, and enhance soil biological activity. Organic mulch may be selected for such attributes rather than on the basis of weed control alone. Organic mulch may affect crop yields through other means than the influence on nitrogen in the soil. The effect that organic mulch has on soil temperatures may ultimately impact yields.

Conclusion

Farmers are advised to use dry rice straw as a mulching material alongside with poultry manure for sweet melon production in Dadinkowa metropolis so as to increase its quality and yield.

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Table 1: Physical and chemical properties of the soil used for the experiment during the 2013 dry season.

Mechanical composition	Soil depth 0-30cm
Sand %	86.88
Silt%	7.42
Clay%	11.24
Organic carbon%	5.44
pH in H_20	6.52
Total nitrogen %	3.56
Available phosphorus mg kg^{-1}	2.24
Available potassium mg kg^{-1}	1.58
Available calcium mg kg^{-1}	0.58
Available sodium mg kg^{-1}	0.53
Available magnesium mg kg^{-1}	1.35
Cation exchange capacity (CEC) mg kg^{-1}	5.23

Table 2: Growth parameters of sweet melon as influenced by mulch and organic manure in 2013 dry season at Dadinkowa

	Vine length (cm) $plant^{-1}$			Number of leaves $plant^{-1}$			Number of vines $plant^{-1}$		
Mulch	4WAS	8WAS	12WAS	4WAS	8WAS	12WAS	4WAS	8WAS	12WAS
No mulch (control)	12.47c	14.55c	25.34c	8.43c	10.58c	17.32b	3.22a	3.42a	3.43a
White plastic mulch	14.52b	17.58b	25.44b	10.56b	12.54b	18.45b	3.38a	3.48a	3.46a
Black plastic mulch	15.50b	16.77bc	26.37bc	8.54bc	12.65b	20.46ab	3.41a	3.48a	3.47a
Dry rice straw mulch	17.36a	25.46a	28.47a	12.46a	14.76a	22.43a	3.47a	3.48a	4.48a
SE±	2.22	2.28	2.32	1.22	1.24	2.36	0.23	0.33	0.36
Organic manure (10 tons ha^{-1})									
No manure (control)	12.48c	14.56c	25.36c	8.45c	10.61c	17.34b	3.22a	3.42a	3.43a
Goat manure	14.54b	17.62b	25.46b	10.58b	12.56b	18.47b	3.38a	3.48a	3.46a
Cow dung	15.52b	16.78bc	26.39bc	8.56bc	12.67b	20.48ab	3.41a	3.48a	3.47a
Poultry manure	17.40a	25.48a	28.49a	12.48a	14.78a	22.46a	3.47a	3.48a	4.48a
SE±	1.24	1.32	1.36	0.68	0.72	1.86	NS	NS	NS
M x OM	*	*	*	*	*	*	NS	NS	NS

Means with the same letter (s) within a column are not significantly different at 5% level of probability (DMRT)

M = Mulch, OM = Organic manure, NS = Not significant, * = Significant at 5% level of probability.

Table 3: Yield parameters of sweet melon as influenced by mulch and organic manure in 2013 dry season at Dadinkowa

	Number of fresh fruits plant^{-1}			Fresh fruit yield(kg) plot^{-1}	Fresh fruit yield (tons) hectare^{-1}
Mulch	10WAS	12WAS	14WAS		
No mulch (control)	4.46a	6.23a	6.58a	3.54d	3.84b
White plastic mulch	4.56a	6.24a	6.59a	3.65c	3.88b
Black plastic mulch	4.58a	6.26a	6.63a	4.68a	3.45ab
Dry rice straw mulch	4.62a	6.28a	6.65a	5.36b	4.62a
SE±	NS	NS	NS	1.23	1.22
Organic manure (10 tons ha^{-1})					
No manure (control)	4.38a	6.24a	6.45a	3.51d	3.68b
Goat manure	4.48a	6.25a	6.56a	3.71c	3.71b
Cow dung	4.49a	6.26a	6.67a	4.45a	3.74ab
Poultry manure	4.52a	6.27a	6.76a	5.31b	4.84a
SE±	NS	NS	NS	1.11	1.12
M x OM	NS	NS	NS	*	*

Means with the same letter (s) within a column are not significantly different at 5% level of probability (DMRT)
M = Mulch, OM = Organic manure, NS = Not significant, * = Significant at 5% level of probability

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Effect of Cassava Production with Polluted Irrigated Water from some Water Bodies in Orumba South L.G.A, South-eastern Nigeria

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Abstract
The effect of irrigated water used in the production of cassava around the shores of two streams and a river in Orumba South Local Government Area of Anambra state. Three samples from each water body (a kilometer apart) were used for analysis for three months. The samples were analyzed for seven heavy metals using Atomic Absorption Spectrophotometer (AAS). The average result showed that these parameters were above WHO permissible levels for most water bodies.

Introduction
Cassava is one of the well-known poverty alleviating root crops primarily grown in most parts of the world including sub-Saharan African, Asia and the Americans (Rabbi *et al.,* 2014). It is a basic food for over 700 million people in Western and Central Africa (FAO, 2010: 2005) with an average consumption of approximately 500 calories per day (FAO, 2010: 2005). Cassava is a perennial crop which bulking duration ranges from 8 weeks after planting to 24 months after planting. This makes cassava to be available all-round the year. Those planted near water bodies are been irrigated during the dry season to improve its yield capacity. Water is very essential in human lives, animals and plants. Great care has to be taken in monitoring the different water bodies for human consumption. Industrial waste, fertilizers, herbicides and pesticides are directly or indirectly introduced into water bodies. The chemical substances get into water bodies through various sources such as erosion, discharging into the water bodies, waste from farms, domestic sludge and human or animal waste (Okafor, 1985). Heavy metals like iron, cadmium, lead, copper, chromium, manganese and zinc accumulates in water bodies above World Health Organization (WHO) permissible levels. These high concentrations of the heavy metals are as a result of discarded materials from various homes, activities of most industrial wastes and incinerator residue (Pickford, 1978). The objective of this study is to evaluate the effect of using polluted water from three water bodies in Orumba South Local Government Area of Anambra State to irrigate cassava production.

Materials and Methods
Two streams and one river from Orumba South L.G.A were sampled. Each of the water bodies were sampled at three points, a kilometer apart for a period of three months.

Sample Collection

The samples were collected in the months of November and December 2003 and January 2004. A sterilized container was used at each point of the sample collection.

Laboratory Analysis

The samples were analyzed for heavy metals using Atomic Absorption Spectrophotometer (AAS) method. The results were subjected to statistical analysis using their means ± standard deviation.

Results and Discussion
The results of the heavy metals in the surface water bodies were compared to the World Health Organization (WHO) standard with the following permissible concentrations Iron 0.3, manganese 0.5, copper 1.0, zinc 15, cadmium 0.01, lead 0.1 and chromium 0.05 all in mg/l (WHO, 1971). Zinc, cadmium and copper fell within the highest desirable level of the WHO for drinking water standards (WHO, 1971). Manganese level fall within the WHO standard with exception of

samples B_2, B_3 and C_1 in table 1. These three samples are not good for irrigation because manganese is very toxic to living tissues. Lead content of the whole water samples are above the WHO standard of the maximum permissible level. Cassava production in these areas will have high accumulated lead which causes kidney disease, stroke and brain damage. Iron content of the whole water samples is above the WHO standard. Iron is not harmful to the body when consumed but its excess in the soil fixes phosphorus. Chromium content is above WHO standard. Cassava irrigated with these water bodies is a potential carrier of cancer disease.

Conclusion

Comparing the results with WHO International Standards for drinking water, it means that people from Orumba South L.G.A have been using substandard water for the irrigation of their cassava farms. ANSEPA should provide treatment of surface water and restrict the disposal of different waste materials in these water bodies.

Table 1: Mean and standard deviation of heavy metals in the selected water bodies

Sampling points	Iron (Fe^{2+}) MgL^{-1}	Manganese (Mn^{2+}) MgL^{-1}	Copper (Cu^{2+}) MgL^{-1}	Zinc (Zn^{2+}) MgL^{-1}	Cadmium (Cd^{2+}) MgL^{-1}	Lead (Pb^{2+}) MgL^{-1}	Chromium (Cr^{3+}) MgL^{-1}
WHO STD	0.3	0.5	1.0	15	0.01	0.1	0.05
A_1	1.267±0.59	0.408±0.00	0.079±0.04	1.568±1.65	0.007±0.0007	1.393±0.35	0.635±0.50
A_2	1.018±0.32	0.400±0.00	0.090±0.02	1.597±1.68	0.008±0.05	1.334±0.31	0.927±0.34
A_3	1.242±0.13	0.414±0.00	0.229±0.11	1.617±1.68	0.007±0.005	5.503±6.34	0.961±0.46
B_1	1.204±1.00	0.143±0.00	0.187±0.06	1.716±1.60	0.005±0.004	0.399±0.30	1.220±0.48
B_2	1.290±1.20	0.806±0.00	0.216±0.16	1.632±1.61	0.005±0.004	0.641±0.21	0.837±0.62
B_3	1.122±1.02	0.705±0.00	0.167±0.11	1.660±1.63	0.005±0.004	0.923±0.20	0.987±0.73
C_1	0.790±0.60	0.559±0.00	0.165±0.19	0.532±0.15	0.07±0.007	0.886±0.72	1.097±1.18
C_2	1.165±1.31	0.418±0.00	0.553±0.14	0.553±0.14	0.003±0.0003	0.556±0.38	1.231±1.24
C_3	0.763±0.61	0.385±0.00	0.575±0.15	0.575±0.15	0.003±0.0007	0.233±0.08	1.238±1.23

A1 - Ezudo stream point 1
A2 - Ezudo stream point 2
A3 - Ezudo stream point 3
B1 - Aghomili river point 1
B2 - Aghomili river point 2
B3 - Aghomili river point 3
C1 - Osu stream point 1
C2 - Osu stream point 2
C3 - Osu stream point 3

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Influence of varying rates of Organo-Mineral and NPK Fertilizers on Performance of *Solanum macrocarpon* (eggplant) in Ikorodu Agro Ecological Zone

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Abstract
The focus of the study was to evaluate the effects of varying rates of organomineral and NPK fertilizers on growth performance of Solanum macrocarpon (eggplant) in Ikorodu area of Lagos state. The treatments include five organomineral fertilizer rates (0, 2.5, 5, 7.5, and 10 t/ha) which were applied at transplanting and NPK 15:15:15 fertilizer (200 kg/ha) applied a week after transplanting. Parameters used for comparison include plant height (cm), stem girth (cm), number of leaves, number of branches, leaf area index (cm$^{2)}$ at 2, 4 and 6 weeks after transplanting (WAT)) and leaf yield at harvest. Findings from the study indicated that application rates of organomineral fertilizer significantly improves the plant height, stem girth, number of leaves, number of branches, leaf area index and yield of S. macrocarpon compared to control plots, as rate of fertilizer increases, growth and yield of S. macrocarpon tends to increases concurrently with 10 t/ha rate resulted in maximum growth performance and shoot yield.
Keywords: Application rates, Growth performance, Organomineral Fertilizer and Solanum macrocarpon

Introduction
The increasing demand for eggplants is due to the increasing awareness toward the benefit of leafy vegetables in fulfilling the nutritional and health benefits of increasing human population in the south west Nigeria. Owing to high demand for eggplant leafy vegetable, the production should be increased as well rather its cultivation has reduced drastically in the last couple of years. One of the main causes of such reduction is the decreasing fertility of the soil and organic matters in the soil (Ullah *et al.*, 2008). Most soils in Sub-Sahara African are used for subsistence farming and are of low and declining fertility (Buresh *et al*., 1997) and adequate soil fertility is essential for sustainable vegetable production especially in urban and peri-urban centres. Thus, the application of fertilizer or manure for amelioration of soil fertility is an integral part of leafy vegetable production. The shortcomings associated with both mineral and organic fertilizers led to the introduction of a new fertilizer called organomineral fertilizers. Recently, some state governments in Nigeria have embarked on industrial production of organomieral fertilizer derived from household waste materials. Various researchers have found organomineral fertilizers to significantly increase the yield of maize and vegetables such as pepper, tomato, okra, melon and amaranthus (Adeoye et al, 2008; Akanni and Ojeniyi 2008; Ojeniyi et al, 2009; Makinde et al 2010). However, in litteratures there appear to be dearth of information on the utilization of organomineral for the cultivation of eggplant in the study area. Therefore, this study aims at evaluate the effect of varying rates of organomineral fertilizer compared with a fixed rate of NPK 15-15-15 fertilizer on the growth and yield performance of *Solanum macrocarpon* (eggplant) in Ikorodu agro ecological zone.

Materials and Methods

Experimental location and land preparation

The experiment was carried out at the Teaching and Research Farms, Lagos State Polytechnic, Ikorodu, Lagos State Nigeria located in the humid tropical rainforest agro-ecological zone. The experimental site has been under continuous cultivation for over three years without any form of soil amendments. The land was ploughed and harrowed to a fine tilt using a disc plough and harrow. Land clearing and marking out were done and suitable beds of equal size of 3m x 2.5m were made with hoe.

Soil analysis

Composite soil samples were randomly collected with auger from ten (10) different locations in the study area and were composited, air dried and sieved through 5mm sieve and their physiochemical characteristics were determined before application of treatment following standard laboratory procedure (Page *et al*., 1989)

Crop establishment and maintenance

S. macrocarpon seeds were sown in nursery via broadcasting and nursery management lasted for four weeks. Transplanting was carried out at a spacing of 50cm x 50cm at 4weeks after sowing with one plant per hole. Irrigation was carried regularly and weeding was carried out as at when due and pest and disease was controlled using chemical method of control.

Experimental Design and treatment application

The experiment was laid out in Randomized Complete Block Design (RCBD**)** on a total land area of 179.5m^2 which was divided into 3 blocks of 21m x 2.5m (52.5m^2), each plot size was 3m x 2.5m (7.5m^2) with a discard of 0.5m which gave a total number of 18 plots. Five (5) rates of organomineral fertilizer: 0, 2.5, 5.0, 7.5, 10t/ha^{1}and NPK 15:15:15 at 200kg/ha respectively was applied to the plots at transplanting, while NPK 15:15:15 was applied a week after transplanting by band placement and replicated 3 times.

Data collection and Statistical Analysis

Six (6) plants were tagged per plot, from which growth and yield parameters were taken at 2, 4, 6 and 11 weeks after transplanting (WAP) respectively. Data collected was analyzed statistically with Analysis of Variance (ANOVA), and significant means was compared with Duncan Multiple Range Test (DMRT) at 5% level of probability using ASSISTAT 7.7 beta statistical software (2015).

Results and Discussion

Initial soil fertility analysis

The pre-cropping physical and chemical characteristics of the experiment soil shows that the soil is sandy clay loam in texture (sand 72.50%, silt 27.0% and clay 0.50%) and slightly acidic with pH 6.47. The soil is low in Organic Carbon (1.02%), Total N (0.08%), Available P (3.42mg/kg^1), exchangeable bases Na (0.74cmol/kg), K (0.01cmol/kg), Ca (0.85cmol/kg) and Mg (1.26cmol/kg).

Effect of organomineral and NPK fertilizers on plant height

Results from Table 1 indicated that both organomineral and NPK fertilizers did not significantly ($p<0.05$) affects plant height. However, at 4 and 6 WAT, 2.5 t/ha produced the tallest plant followed by 10 t/ha, 5 t/ha NPK 200 kg/ha and control had the shortest plant. At 2 WAP plots that received 10 t/ha OMF produced the tallest plants followed by 7.5 t/ha, 2.5 t/ha, 5 t/ha, and control treatment (3.33cm) which still gave taller plant than NPK 200 kg/ha (3.20) which recorded the lowest plant height

Table 1: Effect of varying rates of organomineral and NPK fertilizers on plant height on plots planted with *solanum macrocarpon* at 2, 4, and 6 weeks after transplanting

Treatments	2WAP	4WAP	6WAP
OMF 0/ha	3.33	3.97	4.87
OMF 2.5t/ha	3.90	4.80	6.37
OMF 5t/ha	3.80	4.53	5.93
OMF 7.5t/ha	3.93	4.77	5.93
OMF 10t/ha	3.97	4.73	6.17
NPK 15:15:15 200kg/ha	3.20	4.60	5.63

OMF =Organomineral fertilizer

Effect of organomineral and NPK fertilizers on number of leaves

Table 2 shows the effect of varying rates of OMF and NPK fertilizers on the number of leaves of eggplant. Number of leaves at 2 and 4WAT were significantly ($p<0.05$) affected by varying rates of OMF and NPK fertilizers as the result reveals but no significant effect ($p<0.05$) at 6WAT. Although control treatment produced the maximum number of leaves at 2 WAT and differs significantly compared to other treatments, while there was no significant difference between 7.5, 10 t/ha OMF and NPK. While, at 4 WAT 10 t/ha produced maximum number of leaves (9.40) followed by 2.5 t/ha (8.07), NPK 200 kg/ha (7.70), 7.5 t/ha, 5 t/ha (6.73) and control (5.87). similar trend was observed at 6 WAT.

Table 2: Effect of varying rates of organomineral and NPK fertilizers on number of leaves on plots planted with *Solanum macrocarpon* at 2, 4, and 6 weeks after transplanting

Treatments	2WAP	4WAP	6WAP
Control	4.40a	5.87b	8.70
OMF 2.5t/ha	4.07ab	8.07ab	10.47
OMF 5t/ha	3.33b	6.73ab	8.67
OMF 7.5t/ha	3.97ab	7.67ab	10.00
OMF 10t/ha	4.33ab	9.40a	11.40
NPK 15:15:15 200kg/ha	3.77ab	7.70ab	9.60

Means with different letter(s) in the same column are significantly different at 5% D.M.R.T.
OMF =Organomineral fertilizer

Effect of organomineral and NPK fertilizers on stem girth

Data recorded in Table 3 showed the effect of varying rates of OMF and NPK fertilizers on the stem girth of *S. macrocarpon*. The result obtained reveals that the varying rates of both fertilizers did not significantly ($p>0.05$) affect the stem girth of *S. macrocarpon* at all weeks. Therefore, with regards to the result, the eggplant shows no peculiar trend in the stem girth as the plant progresses. However, the 10 t/ha (0.63) had the widest stem girth followed by 7.5 t/ha (0.53), 5.0 t/ha (0.53) and 2.5 t/ha (0.50), NPK 200 kg per hectare (0.50) and control (0.50) having similar value at 6WAT.

Table 3: Effect of varying rates of organomineral and NPK fertilizers on stem girth on plots planted with *Solanum macrocarpon* at 2, 4, and 6 weeks after transplanting

Treatments	2WAP	4WAP	6WAP
Control	0.23	0.37	0.50
OMF 2.5t/ha	0.20	0.37	0.50
OMF 5t/ha	0.17	0.33	0.53
OMF 7.5t/ha	0.17	0.33	0.53
OMF 10t/ha	0.20	0.40	0.63
NPK 15:15:15 200kg/ha	0.20	0.33	0.50

OMF =Organomineral fertilizer

Effect of organomineral and NPK fertilizer on leaf area index

Table 4 presents effect of varying rates of OMF and NPK fertilizers on leaf area index of *S. macrocarpon*. Varying rates of OMF and NPK fertilizers did not significantly ($p<0.05$) influence the leaf area index throughout the weeks of assessment of *S. macrocarpon* and the leaf area index increases with ageing. Control gave the lowest leaf area index at 2, 4 and 6 WAT and OMF 2.5t/ha and OMF 7.5t/ha produced the maximum leaf area at 2, 4 and 6 WAT respectively.

Table 4: Effect of varying rates of organomineral and NPK fertilizers on leaf area index on plots planted with *Solanum macrocarpon* at 2, 4, and 6 weeks after transplanting.

Treatments	2WAP	4WAP	6WAP
Control	5.00	8.18	11.99
OMF 2.5t/ha	8.26	17.78	17.88
OMF 5t/ha	7.63	15.34	20.25
OMF 7.5t/ha	7.79	17.59	22.66
OMF 10t/ha	7.10	13.35	18.20
NPK 15:15:15 200kg/ha	6.37	13.84	18.02

OMF =Organomineral fertilizer

Effect of organomineral and NPK fertilizers on number of branches

Results from Table 5 indicated that the effect of varying rates of OMF and NPK fertilizers did not significantly influenced number of branches produced by *S. macrocarpon*. In all the treatments, number of branches produced by the *S. macrocarpon* increases with the age of the plant and in responses to the different of fertilizers application.

Table 5: Effect of varying rates of organomineral and NPK fertilizers on number of branches on plots planted with *Solanum macrocarpon* at 2, 4, and 6 weeks after transplanting

Treatments	4WAP	6WAP
OMF 0/ha	1.90	2.83
OMF 2.5t/ha	2.37	3.07
OMF 5t/ha	2.00	2.93
OMF 7.5t/ha	2.77	3.70
OMF 10t/ha	2.57	3.20
NPK 15:15:15 200kg/ha	2.30	3.57

OMF =Organomineral fertilizer

Effect of varying rates of organomineral and NPK fertilizers on marketable shoot yield

Results from Table 6 indicated that marketable shoot yield of *S. macrocarpon* was not significantly influenced by the varying rates of OMF and NPK fertilizers. The results show that 10 t/ha gave the highest marketable shoot yield (0.40kg/ha) followed by NPK 200 (0.35kg/ha), 2.5 t/ha (0.30kg), 7.5 t/ha (0.29kg), 5 t/ha (0.20kg) and control (0.18kg) which had the least marketable shoot yield

Table 6: Effect of varying rates of organomineral and NPK fertilizers on marketable shoot yield (kg) of *Solanum macrocarpon*

Treatments	Yield(kg)
Control	0.18
OMF 2.5t/ha	0.30
OMF 5t/ha	0.20
OMF 7.5t/ha	0.29
OMF 10t/ha	0.40
NPK 15:15:15 200kg/ha	0.35

OMF = Organomineral fertilizer

Cost analysis of *S. macrocarpon* production

The table below showed the total cost incurred on the production of eggplant to be ₦5061. Result from Table7 indicated that the yield obtained from 10 t/ha OMF was the highest with resulting revenue of ₦120 followed by NPK 200 kg/ha (₦110), 7.5 t/ha OMF (₦90), 2.5 t/ha (₦90), 5 t/ha (₦60) and control (₦50). Therefore, all the treatments had gross margins less than ₦1:00 which makes production non profitable or beneficial. However, the low revenue could be attributed to the time the project was terminated.

Table 7: Cost analysis of *S. macrocarpon* production

Variables	control	2.5t/ha OMF	5t/ha OMF	7.5t/ha OMF	10t/ha OMF	NPK 200 kg/ha	Total
Revenue							
Leaf yield	0.5kg	0.9kg	0.6kg	0.9kg	1.2kg	1.1kg	5.2kg
Selling price/kg	₦100	₦100	₦100	₦100	₦100	₦100	₦100
Revenue from sales of produce	₦50	₦90	₦60	₦90	₦120	₦110	₦520
Total revenue(TR)	₦50	₦90	₦60	₦90	₦120	₦110	₦520
Variable costs							
seeds	₦200	₦200	₦200	₦200	₦200	₦200	₦1200
Land preparation	₦150	₦150	₦150	₦150	₦150	₦150	₦900
Fertilizer	₦0	₦95	₦190	₦280	₦375	₦21	₦961
Transportation of fertilizer	₦0	₦100	₦100	₦100	₦100	₦100	₦500
Labour cost	₦150	₦150	₦150	₦150	₦150	₦150	₦900
Harvesting	₦100	₦100	₦100	₦100	₦100	₦100	₦600
Total Variable Cost (TVC)	₦600	₦795	₦890	₦980	₦1075	₦721	₦5061
Gross Margin (TR - TVC)	- ₦540	- ₦705	- ₦830	- ₦890	- ₦955	- ₦611	-₦4541

The low fertility status observed in the soil can be attributed to continuous cropping and increased land use intensity. This confirmed previous observation by Ojeniyi and Akanni, 2008 that soils in south-west Nigeria which are mostly weathered alfisols were deficient in nutrients especially OM, total N, available P, exchange K and Ca; thus the needs for amendment with organic and inorganic fertilizer sources to improve the availability of these nutrients in soil which was low in the soil. The contents of base elements (K, Ca and Mg) in OMF will serve to reduce soil acidity and it is benefit the soil and in return increase eggplant growth and yield. The improved growth parameters observed was due to nutrient sources and the release of mineral elements such as N, P, K and exchangeable cations (Ca, Mg and Na) to the soil by the different fertilizer sources which established and maintained optimum soil physical condition for plant growth. The result showed that different fertilizers enhanced plant growth; taller plants produced more leaves and capture more light energy and had more photosynthate available for plant growth and development. The increased shoot yield may be attributed to more photosynthetic activities of the plant on the account of adequate supply of nitrogen with increasing rates of fertilizer from different sources. In all the treatments, eggplants responded directly proportional to the varying levels of OMF applied and this supported the finding of Jibrin (2011) who opined that the quantity of organic manure applied determines the level of productivity of the plant. The differences in the variable cost observed are attributable to the different rates of fertilizers used. This is supported by the findings of Ngbede et al (2014) on urban vegetable production. This is in agreement with the report of Akanbi et al (2006) that the yield obtained from the optimum application of organo-mineral fertilizer on okra was high enough to compensate for the high cost of production incurred.

Conclusion

Apparently the results from the study show that organomineral fertilizer application is of great benefits for crop vegetative growth. In all the rates applied, 10 t/ha resulted in maximum growth performance and shoot yield. *S. macrocarpon* farmers in the study area should be encourage to adopt organomineral for the crop cultivation since its readily available and not bulky compared to inorganic organic fertilizers respectively.

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Effect of Downy Mildew [*Sclerospora graminicola* (Sacc.)] Infestation and Rating of Selected Pearl Millet [*Pennisetum glaucum* (L.) R.Br.] Varieties (*Maiwa* and *Gero*) and their Hybrids

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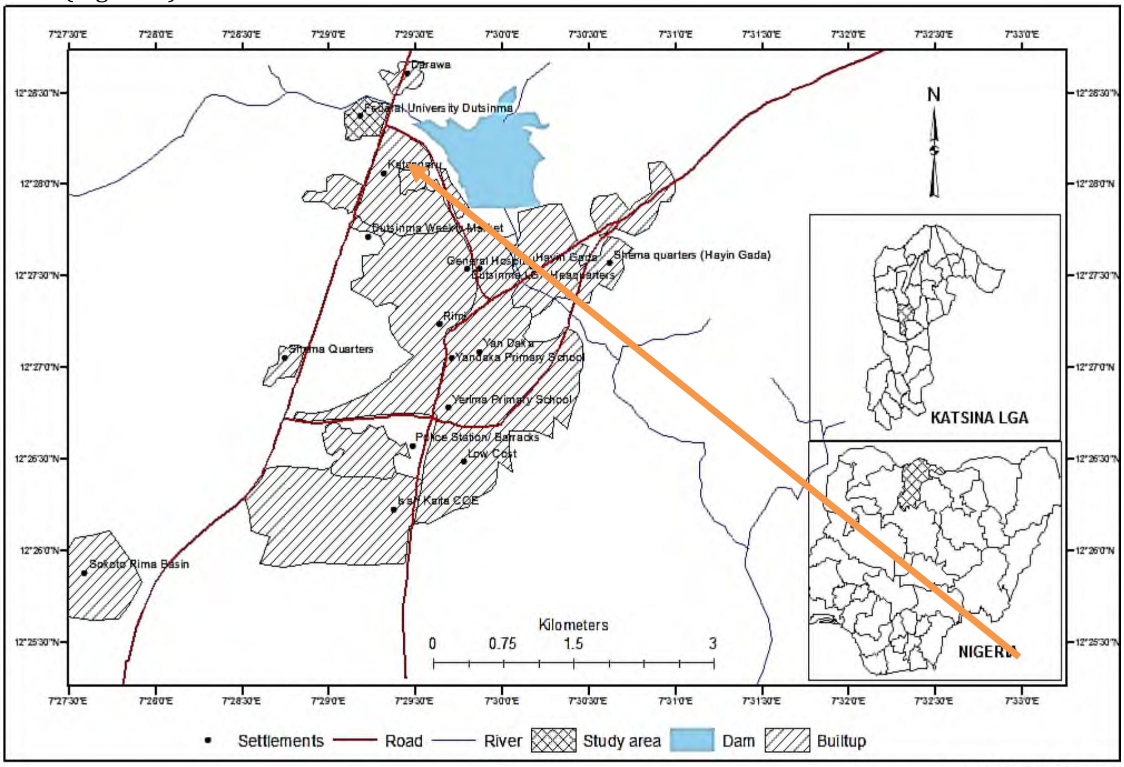
Abstract
Varieties of pearl millet were tried for two growing seasons to assess their response to downy mildew. In the first year the pearl millets were evaluated using infector row system. The infector rows were made of bulk of local varieties which were inoculated with downy mildew inoculum. The indicator rows were Jirani variety of pearl millet which are very susceptible Downy Mildew disease. In the second year, the infector rows were not inoculated with downy mildew inoculum. The Maiwa varieties that were found to be resistant to downy mildew infection were selected and crossed with Gero varieties that showed some level of susceptibility to downy mildew infestation during the off season in a screen house. The hybrids generated were then evaluated along with their parents on downy mildew infested plot with the aim of testing their resistance and susceptibilities. 2 female parents are highly resistant, 12 hybrids were highly resistant, 6 genotypes were resistant and 5 were moderately resistant.

Introduction
Pearl millet [*Pennisetum glaucum* (L.) R.Br.] was domesticated as a food crop in the tropical region of West Africa at least 4000 years ago. Its use as a food grain has grown over the centuries, with an estimated 64 million acres of pearl millet being grown in Africa and India (Robert 2018). Millets are nutritionally superior as their grains contain high amount of proteins, essential amino acids, minerals, and vitamins (Vinoth and Ravindhran, 2017). The crop is used for a variety of food products, and is even made into a type of beer. In resource-poor countries of Asia and Africa, millets provide 75% of total calorie intake next to cereal grains with an average annual production of 14.2 and 12.4 million tons (Belton and Taylor, 2004; O'Kennedy *et al*., 2006). India is the Leading producer of millets accounting for about 80% of the global millet production (Food and Agricultural Organization (FAO, 2015). Among the millets, pearl millet occupies 95% of the production (Yadavetal., 2012; Yadav and Rai, 2013; Agricultural Statistics, Government of India, 2014; Nedumaran *et al*., 2014). Downy mildew (DM) or 'green ear' disease caused by *Sclerospora graminicola* (Sacc.) Schroet. occurs most destructively in Asia and Africa (Arya HC and Kumar A. (1976), Nene YL and Singh SD. (1976), Rachie and Majmudar, (1980) and Singh, (1995)). The disease was considered of minor importance till 1970, as its incidence was sporadic on local cultivars. The first epidemic of downy mildew occurred in 1971 on the first popular pearl millet hybrid, HB 3, resulting in severe grain loss of about 4.6 million metric tons (Singh, 1995), Singh *et al*., (1993). As a result of continued large-scale cultivation of the susceptible hybrids, the disease caused serious epidemics during 1974, 1984, 1987 and 1988 (Arun *et al*., 2012). It is important to determine the effect if this disease on some varieties of pearl millet.

Materials and Methods

Study Area

This experiment was conducted at the Agroforestry farm layout, Federal University Dutsin-Ma, Katsina State, Nigeria. Dutsin-Ma lies between latitude 12º 27' and 22''N and longitude 7º 30' and 83''E (Figure 1).



Source: FUDMA GIS Lab.

Figure 1: Map of Katsina State showing Dutsin-Ma LG.A. / Federal University, Dutsin-Ma
Source: Modified from the Administrative Map of Katsina State.

The daily minimum and maximum temperatures range from 32ºC to 43ºC. Dutsin-Ma, in Katsina State experiences unimodal rainfall pattern with an annual rainfall of about 1100 mm, with a single peak in August. Dry season lasts for a minimum of seven months (November-May) while the wet season spans June to October.

Design of the Study

Crosses were obtained using a factorial mating scheme of North Carolina Design II, where each male was mated to each of the female (Comstock and Robinson, 1948; Hallauer and Miranda, 1981). The field evaluation was done using complete Randomized Block Design (CRBD) two replications. Hybrids and parents were allocated to plots using random table number.

Data Analysis

Downy mildew incidence was calculated as:

$$\text{DMI}=\frac{\text{Number of diseased seedlings}}{\text{Total number of seedlings per pot}}\times 100$$

where DMI =Downy mildew incidence

Downy mildew incidence data were analyzed using Statistical Analysis System (SAS, 9.1, 2003). For classifying the pearl millet genotypes the rating scale of Ball (1983) was adopted:

0-5% disease incidence = Highly Resistant (HR)
5-10% disease incidence = Resistance (R)
10-25% disease incidence = Moderately Resistant (MR)
25-50% disease incidence = Moderately Susceptible (MS)
50-80% disease incidence = Susceptible(S)
>80% disease incidence = Highly Susceptible (HS)

Results and Discussion

Table 1 presents the results of thirty genotypes comprising of parents and hybrids for downy mildew infestation. The results indicated two of the male parents that were resistant in the first two seasons became moderately susceptible in the third season at the same location. This indicates either a shift in virulence of the pathogen or a shift in resistance of genotypes used. Similar results were obtained in Ati *et al*., (2013) and (2015). Thakuret *et al*., (2009) found that a major change in disease incidence of pearl millet line over time at the same location reflected virulence shift in the pathogen population. Downy mildew pathogen is heterothallic and frequent recombination leads to genetic diversity and evolution of new virulent population. Hence identification of resistance to new virulence population is a prerequisite for resistance breeding (Thakuret *et al*.; 2009). Among five female parents only one maintained it status of being susceptible to the pathogen, the remaining 4 female parents gained resistance to the pathogens while among the male parents, one was resistant, two moderately resistant and two were moderately susceptible. Fourteen of the genotypes were highly resistant to the pathogen (3 parents and 11 hybrids). The rest of the hybrids were resistant to the pathogens except one (GMC17001XMMC17006, the only susceptible genotype among the 30 genotypes study).

Table1: Mean Performance of Downy Mildew Rating for twenty Hybrids and Their Parents

S/N	GENOTYPES	NHE	PltVig	DMI	DMI RATING
1	GMC17001 X MMC17010	17.5a	4a	0c	HR
2	GMC17005XMMC17007	14.5 ab	4a	0c	HR
3	MMC17007	14.5ab	3ab	9.09bc	R
4	GMC17003 X MMC17007	13.5abc	3.5ab	6.67bc	R
5	GMC17004 X MMC17007	12.5abc	3ab	17.36bc	MR
6	GMC17004	12.5abc	3ab	4.17bc	HR
7	GMC17001 X MMC17007	12abcd	2.5ab	0c	HR
8	MMC17008	12abcd	3ab	16.08bc	MR
9	GMC17005 X MMC17008	12abcd	3.5ab	0c	HR
10	GMC17002 X MMC17010	11.5abcd	3ab	0c	HR
11	GMC17002	11abcd	2.5ab	3.85bc	HR
12	GMC17002 X MMC17009	11abcd	3ab	0c	HR
13	GMC17004 X MMC17008	10.5abcd	2.5ab	0c	HR
14	MMC17010	10.5abcd	2.5ab	15.28bc	MR
15	GMC17002 X MMC17007	10abcd	2.5ab	11.54bc	MR
16	GMC17003 X MMC17006	9.5abcd	2.5ab	0c	HR
17	GMC17003	9.5abcd	2.5ab	7.14bc	R
18	MMC17006	9.5abcd	2.5ab	25.60bc	MS
19	GMC17003 X MMC17008	9abcd	2ab	0c	HR
20	GMC17003 X MMC17010	9abcd	2.5ab	14.29bc	MR
21	GMC17004 X MMC17010	9abcd	2.5ab	7.69bc	R
22	GMC17004 X MMC17009	9abcd	2.5ab	0c	HR
23	GMC17005	8.5abcd	2ab	25bc	MS
24	GMC17001	7.5bcd	2ab	7.14bc	R
25	GMC17005 X MMC17006	7.5bcd	2ab	14.29bc	MR
26	GMC17003 X MMC17009	6bcd	2ab	0c	HR
27	GMC17004 X MMC17006	6bcd	2ab	7.14bc	R
28	MMC17009	5bcd	2ab	30bc	MS
29	GMC17001XMMC17006	4cd	1.5b	53.33a	S
30	GMC17002 X MMC17006	2.5d	1.5b	0c	HR

The means followed by the same letter(s) along the same column are not significantly different (Duncan's Multiple Range Test at P< 0.05). *S =Susceptible, HS= highly susceptible, MS= moderately susceptible, MR= moderately resistance.*

Conclusion

Thirty genotypes were evaluated for downy mildew infestation. twenty-six of them were resistant to the pathogen (2 female parents (GMC17004 and GMC17002) are highly resistant, 12 hybrids(GMC17001 X MMC17010, GMC17005 X MMC17007, GMC17001 X MMC17007, GMC17005 X MMC17008, GMC17002 X MMC17010, GMC17002 X MMC17009, GMC17004 X

MMC17008, GMC17003 X MMC17006, GMC17003 X MMC17008, GMC17004 X MMC17009, GMC17003 X MMC17009 and GMC17002 X MMC17006) were highly resistant, 6 genotypes were resistant (MMC17007, GMC17003 X MMC17007, GMC17003, GMC17004 X MMC17010, GMC17001 and GMC17004 X MMC17006, and 5 were moderately resistant (GMC17004 X MMC17007, MMC17008, MMC17010, GMC17002 X MMC17007 and GMC17005 X MMC17006) while four were susceptible. Among these four, two were male parents (MMC17009 and MMC17006) that are resistant to the pathogen during the first two years of evaluation; one female parent (GMC17005) maintained her susceptibility to the downy mildew while one hybrid (GMC17001XMMC17006) was susceptible. These twenty-six genotypes were identified as downy mildew resistant varieties.

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Effect of Applied Animal Manure from Different Sources of Plant Materials on Growth and Yield Performance of Maize (*Zea mays* L.) in Ganye, Adamawa State, Nigeria

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Abstract
This study was conducted at the Teaching and Research farm of Adamawa State College of Agriculture, Ganye, Nigeria, to evaluate the effect of applied animal manure from different sources of plant materials on growth and yield performance of maize (Zea mays L.) in Ganye, Adamawa state, Nigeria. The experiment was laid out in Randomized Complete Block Design (RCBD), with three replications having five treatments: T_1 = manure obtained by feeding West African dwarf goat with brewer's dried grain + cowpea husk, T_2 = brewer's dried grain + Ficus sycomorous, T_3= brewer's dried grain + Vitellaria paradoxa, T_4 = brewer's dried grain + Anogessus leiocarpus, while T_5 was the control with no manure applied. The parameters measured were plant height, leaf length, number of leaves, girth width, cob length, cob width, 1000 grain weight and tones/hectare. The analysis of variance shows that there were significant difference ($p<0.05$) among the treatments applied on the parameters measured. It was discovered that treatment T_1, T_2, T_3, and T_4 produces better difference among the treatments. Therefore, based on the findings, brewer's dried grain + cowpea husk, Ficus sycomorous, Vitellaria paradoxa, and Anogessus leiocarpus leaves when fed to West African dwarf goat as fodder, their dropping can be used by farmers as animal manure for optimum growth and yield of maize production.
Keywords: Organic Manure, Growth, Yield and Mineral Nutrients

Introduction
Maize remains one of the most important grain crops and is geographically the most widely cultivated species all over the world. Maize contributes 62% in the total cereal production. Maize is multipurpose crop and provides food for human beings, fodder for livestock and feed for poultry. It has great nutritional value as it contain about 66.7% starch, 10% protein, 4.8% oil, 8.5% fiber, 3% sugars, and 7% ash (Chaudhary, 1983). It is a major source of income in several developing countries and one of the best sources for bio-fuel in developed countries (Ali et al., 2014). Declining fertility of Nigeria soil is becoming increasingly critical to secure sustainable agricultural productivity. Hence soil productivity maintenance is important in order to enhance agricultural crop production. Soil low organic matter content and erosion problems have predisposed the soils to productivity. Nutrient balance is always an important consideration for crop response to applied fertilizers. Use of inorganic fertilizers can improve crop yield and nutrient availability, but its unwise use can cause nutrient imbalance and environmental pollution in addition to high production cost (Das *et al*., 1991; Oad *et al*., 2004; Ali, 2005; Mbah and Mbagwu, 2006; Mbah *et al*., 2006; and Ali, 2012). The application of N.P.K fertilizer to the soil actually boosts the performance of maize. Nevertheless, its persistence application destroys soil reaction and impedes the activities of soil micro organisms thereby making the soil acidic and toxic for maize production (Omisore 2010). The increasing cost of mineral fertilizers coupled with the inability to condition the soil has brought attention to organic manure in many parts of the developing countries in recent times (Baoteng *et al*., 2006). The application of manures to soil provides potential benefits and serve as soil conditioners through improving soil physical properties including soil structure, water infiltration, soil water holding capacity, aeration and

permeability, soil aggregation, decreased soil crusting, bulk density, and erosion and increasing rooting depth, improving soil organic matter microbial biomass and soil fertility, reducing the amount of synthetic fertilizer needed for crop production (Allison, 1973; Sumner, 2000; Phan et al., 2002 and Blay et al., 2002) . Therefore with increasing demand for sustainable agriculture, and maize production in particular, the study was designed to examine the effects of applied animal manure from different sources of plant materials on growth and yield of maize in the study area.

Materials and Methods

The study was carried out in the teaching and research farm of the Adamawa State College of Agriculture Ganye; it lies between latitude 8^0 24′ and 8^0 25′north and longitude 12^0 04′ and 12^0 05′east. The mean annual temperature of the study area is 26.7^{o}C while the mean annual rainfall ranges between 1100mm and 1600mm with a distinct dry season which begins in November and ends in April and the wet season begins in April and ends in October or sometimes in November (Adebayo, 1999). The major economic activity in the area is agriculture, food crops grown in the area are Maize, sorghum, cowpea, Cassava and Potatoes. While Cash crops such as Ground nuts, Rice, Yam and Sugarcane are produced in large quantities. The major livestock reared in the Zones are cattle, sheep and goats. (Ad seeds, 2004).
The experimental field has been under fallow since 2008, before then sorghum was planted, with no of history of manure application.

Field Preparation

The total land area for the experiment was 135m^2, prepared manually by clearing and marked out using basin formation according to the experimental layout Each plot was 3 m × 3 m (9m^2), with 1.5 m between replication and 0.5 m between each plot and composite soil samples collected from the plots at 0-15cm depth in order to assess the initial phyisco-chemical properties of the soils.

Soil Analysis

The samples were analyzed for pH as described by Bates (1954); particle size was determined using hydrometer method as described by Bouyoucos (1951). Available Phosphorus was be extracted with 1N NH_4F and 0.5N HCl (Bray and Kurtz, 1945). The titrimetric method was used for the determination of Calcium and Magnesium in the soil as described by Black (1965) while the regular Macro-Kjeldahl Method as described by Black (1965) was be used for the determination of soil total Nitrogen. Potassium and Sodium were be determined in 1N neutral NH_4OAc soil extract using Flame Photometry and Exchangeable acidity was determined using the titration method as described by Mclean (1965). The cation exchange capacity was be determined by summation method.

Experimental Design and Treatments

The experiment was carried out in a Randomized Complete Block Design (RCBD) with three replicates and five treatments. Prior to seed sowing, animal manures were applied at the rate of six (6) tons per hectare one week before sowing. Treatment used are:- T_1 = manure obtained by feeding West African dwarf goat with brewer's dried grain + cowpea husk, T_2 = brewer's dried grain + *Ficus sycomorous*, T_3= brewer's dried grain + *Vitellaria paradoxa*, T_4 = brewer's dried grain + *Anogessus leiocarpus,* while T_5 was the control with no manure applied.

Seed collection and sowing

Improved maize seeds (Ife hyb-6 maize variety by Wacot L t d) was purchased from seed vendor in the study area and sown on the plots at the rate of 2 seed per hole at a depth of 3-5 cm, using 75 cm x 25 cm. The seedlings were later thinned to one plant per stand two weeks after emergence making a total of 44 plants per plot.

Weeding

Weeding commenced at two weeks after sowing and subsequent weeding was carried out at 7 and 11 weeks after sowing to minimize weed interference respectively.

Data Collection

Four (4) plants each per plot were randomly selected for determination of growth and yield parameters. The parameters assessed included, plant height at 2, 4 and 12 weeks after sowing (WAS), number of leaves per plant at 12 WAS, days to 50% flowering, number of cobs at harvest, plant length (cm), weight of 1000 grain (g) and yield of maize per hectare (kg/ha). Plant height was measured with tape from the base of the plant to the top of first tassel, number of leaves and grains/cob were obtained by direct counting; grain weight was measured using weighing scale.

Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) and means were separated with Duncan Multiple Range Text (DMRT) according to Wahua, (1999)

Results and Discussion

Table 1 presents the results of physic-chemical soil properties of the study area. The values of particle size distribution indicate that the soil belongs to sandy clay loam textural class and the soil pH measured in water fell within the medium acid class type. The percentage organic carbon content was 1.10%. The percentage nitrogen value of the soil was 0.13%, available phosphorus 4.60 g kg^{-1}. The exchangeable potassium value was 1.05 Cmol (+) kg^{-1} soil and the value of exchangeable calcium was 15.23 Cmol (+) kg^{-1} soil respectively. Exchangeable values of magnesium, sodium and the cation exchange capacity were 8.90, 0.53 17.70 Cmol (+) kg^{-1} soil respectively.

Table 1: Physico-chemical soil properties of the study area

Soil properties	Values
pH	5.45
%Sand	43.38
%Clay	33.44
%Silt	23.18
%Organic carbon	1.10
Ca (Cmol(+)/Kg soil)	15.23
Mg (Cmol(+)/Kg soil)	8.90
Na (Cmol(+)/Kg soil)	0.53
K (Cmol(+)/Kg soil)	1.05
P (mg/kg)	4.60
%N	0.13
CEC	17.70

Regular soil testing is an important element in nutrient management. The results of particle size distribution indicate that the soils belong to sandy clay loam textural class. Soil texture is one of the most important soil physical properties because it influences the ability of a soil to provide water, nutrients, and aeration necessary for plant growth (Brady and Weil, 1996). The soil reaction was observed to be of medium acid class, many agricultural soils are in the pH range of 5.5 - 8.0 (FAO, 2005). The percentage organic carbon content was moderate in the two sites, even though values were lower than the range of 1.37-1. 1.97 reported by Jamala *et al*. 2012 of some selected Fadama soils in Adamawa State. According to Yan *et al*. (2007), soil organic carbon plays an important role in nutrient availability and soil aggregate formation and also improves retention of soil nutrients so that they will eventually be available for plant growth and also serves as a tremendous reservoir or pool of terrestrial carbon that would otherwise be released to the atmosphere. It is well established that nitrogen (N) is the macronutrient often limiting the growth of plants on soil (Vitousek and Farrington, 1997; Michopoulos *et al.*, 2008). The percentage soil nitrogen of the study sites was low, below 0.15% critical level recommended by Sobulo and Osiname (1981), Agboola *et al*. (1982). Available phosphorus was found to be below recommended a critical level of 8.1 $mgkg^{-1}$ soils (Agboola *et al*., 1982). A range of 3 to 30 $mgkg^{-1}$ soil has also been reported (Mamza, 1997). The exchangeable potassium value was moderate, based on the findings of Sobulo and Osiname (1981), whereas Boul *et al*. (1975) suggested a critical minimum of 0.2 Cmol (+) kg-1 soil. The values of exchangeable Calcium obtained indicate the Calcium content was moderate. Sodium is not a plant nutrient and therefore is not necessary for plant growth. High levels of sodium are detrimental to soil tilth and plant growth. Sodium levels are evaluated based on Exchangeable Sodium Percentage (ESP). The ESP is the percent of the cation exchange capacity (CEC) occupied by Na. ESP values above 10 percent are of concern. Table 2 presents the result of response of plant height, leave length, number of leave and girth width to applied animal manure from different sources of plant materials. The response of plant height to applied animal manure shows that there was no significant difference (P>0.05) among the treatments, even though the application of T_1 produced the highest plant height (159.85cm) followed by T_2, T_4, T_3 and T_5 respectively. The response of leaf length to the applied treatments indicates that the application of T_2 gave the highest leaf length (96.54cm) followed by T_3, T_4, T_1, and T_5 respectively. Also the response of treatments on number of leaves showed that there was a significant difference, the application of T_1 gave the highest number of leaves, followed by T_2>T_3>T_2>T_5 in that pattern. The treatments effect on girth width indicated that there was a significant difference (P<0.05), the application of T_2 gave the highest girth width followed by T_1= T_3= T_4. T_5 had the lowest value of girth width. This results agrees with the finding of Anon (2002) who found out that organic manure is an good fertilizer material because of its high nitrogen, phosphorous and potassium contact and it is readily available than the mineral fertilizer and its effect on the soil is stable, slow in releasing nutrition to crop and also improving the soil physical and chemical properties.

Table 2: Effects of Applied Manure from Different Sources of Plant Material on Growth Parameters of Maize

Treatment	Plant Height (cm)	Leaf Length (cm)	No. of leaves	Girth width (cm)
T1	159.85a±37.14	70.69b ± 5.35	33.147a±15.08	6.84ab ± 0.34
T2	146.29a±31.59	96.54a± 18.58	18.86b ± 4.21	7.25a ± 1.23
T3	126.28a±14.54	73.90b ± 4.03	11.33b ± 0.48	6.83ab ± 0.43
T4	134.25a±11.70	71.05b ± 2.95	11.56b ± 0.48	6.83ab ± 0.34
T5	119.06b±32.01	63.44b ± 7.34	9.11b ± 0.44	5.28b ± 0.37

The means followed by the same letter(s) along the same column are not significantly different (Duncan's Multiple Range Test at P< 0.05). T_1 = is a manure obtained by feeding West African dwarf goat with brewer's dried grain + cowpea husk, T_2 = brewer's dried grain + *Ficus sycomorous*, T_3= brewer's dried grain + *Vitellaria paradoxa*, T_4 = brewer's dried grain + *Anogessus leiocarpus,* while T_5 was the control with no manure applied.

Table 3 shows the effect of applied animal manure on yield parameters of maize. The result of the analysis of variance indicated that there was significant difference (P<0.05) among the treatments applied. The applications of T_1, T_2, T_3, and T_4 yield the highest values of maize cob length, cob girth, 1000 grain weight and maize yield tons/hectare. The control gave the lowest values with regards to these yield parameters. The number of grains/cob of maize obtained from plants that received T_1, T_2, T_3, and T_4 treatments was higher than the number of grains obtained from plants that received the control treatment, possibly because more nutrients were released which mineralized rapidly for plant uptake and utilization. It could also be attributed to increased microbial activities which increases nutrient release in soil as observed by Gopinath *et al*.,(2008), Olanikan(2006) and Enujeke *et al.*,(2013). These reports are generally in harmony with the work and recommendations of Brady and Weils, (1999), DIPA, (2006).

Table 3: Effects applied animal manure from different sources of plant material on yield parameters of Maize

Treatment	Cob Length (cm)	Cob width (cm)	1000 grain weight (g)	Tones/Hectare
T1	15.74a ± 0.52	10.15a ± 0.11	222.28a ±18.01	4.40a ± 0.00
T2	13.52a ± 0.50	9.73a ± 0.05	209.71a±12.17	4.58a ± 0.33
T3	14.55a ± 1.78	10.30a ± 0.32	208.88a±10.96	4.40a ± 0.64
T4	15.50a ±0.52	10.12a ± 0.19	224.27a ± 3.49	4.45a ± 0.10
T5	8.54b ± 0.70	7.01b ± 0.18	150.51b± 1.55	3.18b ± 0.03

The means followed by the same letter(s) along the same column are not significantly different (Duncan's Multiple Range Test at P< 0.05).

Conclusion

This study shows that the use of animal manure derived from brewer's dried grain + cowpea husk, *Ficus sycomorous*, *Vitellaria paradoxa*, and *Anogessus leiocarpus* leaves and fed to West African dwarf goat as fodder, can be used to improve both the chemical and physical properties of the soil, thereby increasing the growth and yield of maize. The application of these manure highly increase plant height, number of maize leaves, stem girth, and other yield attributes of maize at harvest

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Performance of Maize (*Zea mays* L.) Inbred Lines for some Agronomic and Kernel Quality Traits

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Abstract

Field experiment was conducted at Institute for Agricultural Research, Samaru (11°11´N; 07°38'E) in the Northern Guinea Savanna ecological zone of Nigeria between July-October, 2014 rainy season to evaluate the performance of white maize inbred lines based on agronomic and kernel quality traits. White kernel inbred lines of maize totaling 6, were obtained from International Institute of Tropical Agriculture (IITA) for the study which were crossed using half diallel mating design. The 15 hybrids, 6 parents and 4 checks were generated and evaluated at Institute for Agricultural Research Farm, Samaru (11^{0}11´N; 07^{0}38'E) in the Northern Guinea Savanna ecological zone of Nigeria in a 5 × 5 partially balanced lattice design with three replications between July to October, 2014 rainy season. Each plot consists of two rows 4 m long, with inter and intra row spacing of 0.75 m x 0.25 m and 1m alleys respectively. All agronomic practices were kept uniform in all plots. Data were taken on five centered plants for observations and measurements leaving the plants on either end of the plot to avoid the border effect The result indicated significant differences ($p \leq 0.05$) among the genotypes for the following traits plant height, days to maturity, ear height, ear length, field weight, milling test and yield indicating presence of genetic variability in the genotypes. Percent whole kernel, percent kernel without pericarp damage, moisture content at harvest, grain weight, volume and density were not significant., P1 x P2 recorded the highest mean For grain yield per hectare (10650kgha^{-1}) and mean weight (4.19kg) while For per cent kernel without pericarp damage P1 x P5 had had the highest mean value which ranged from 58.00 % to 74.67 % with a CV 11.82 %. Genotype P3 x P4 had the highest mean for milling test (7.06 kg). For moisture content at harvest P4 x P6 had the highest mean (15.87%). For 100-grain weight P2 x P5 had the highest grain weight (11830.00g). Genotype P1 x P4 had the highest mean for volume (24.33m^{3}). P1 x P6 had the highest mean for density (705.50kgm^{-3}).Variations were obtained for most of the studied traits, indicating the presence of appreciable variability in the studied genotypes, which is a key requirement in a crop enhancement programme. The result of this study also showed that hybrid crosses could be developed for specific environment as indicated by significant difference in the performance of genotypes for most of the traits measured.

Keywords: Maize, Inbred Lines, Kernel, Agronomic and Traits

Introduction

Maize (*Zea mays* L.), the third most important cereal crop after wheat and rice in the world (FAO,2002) provides food and feeds, employment and income generation for small-holder families and raw materials for industries in Africa and the humid tropics. The crop is widely cultivated in tropical Africa, and no other crop is more widely distributed in Nigeria. Despite the volume of improvement research and extensive heterosis exploitation in maize (Kim, 1996); (Ogunbodede,2001); (Badu *et al*, 2010) ; (Badu *et al*, 2011), the yield of maize in the tropics is lower than that realizable in the temperate countries. This has made consistent and continuous selection for higher grain yield imperative. Genetic improvement of a crop is pivoted on the strength of genetic diversity within the crop species. Adequate variability provides options from which selections are made for improvement and possible hybridization. The objective of this study is to evaluate the agronomic performance and kernel quality traits in white maize inbred lines.

Materials and Methods

White kernel inbred lines of maize totaling 6, were obtained from International Institute of Tropical Agriculture (IITA) for the study which were crossed using half diallel mating design. The 15 hybrids, 6 parents and 4 checks were generated at Institute for Agricultural Research Farm, Samaru (11⁰11′N; 07⁰38'E) in the Northern Guinea Savanna and evaluated at National Horticultural Research Institute, Bagauda Research Farm (11°33′N; 8°23′E) in the Sudan Savannah ecological zone of Nigeria in a 5 × 5 partially balanced lattice design with three replications between July to October, 2014 rainy season. Each plot consists of two rows 4 m long, with inter and intra row spacing of 0.75 m x 0.25 m and 1m alleys respectively. All agronomic practices were kept uniform in all plots. Data were taken on five centered plants for observations and measurements leaving the plants on either end of the plot to avoid the border effect. Data were recorded for agronomic and kernel quality traits (Days to 50% tasselling , Days to 50% silking, Anthesis silking interval, plant height, days to maturity, ear height, % whole kernel, % kernel without pericarp damage, density, milling test, moisture content at harvest and grain yield). Statistical Analysis was computed using Statistical Analysis System (SAS, 2004) for individual location. The ANOVA was computed on plot mean values for all characters across the two locations. The following model (Bohren *et al.*, 1963) was used for one location in one year.

Table 1: Origin and Descriptions of the Genotypes

Genotype	Pedigree	Colour	Source, Description
P1	P43SRC9FS100-1-1-8-#1-B1-13-B1-B-B-B-B-B-B-B-B	White	IITA, Dent
P2	1368× HI ×4269-1368-7-2-B-B-B-B-B	White	IITA, Dent
P3	9071-B-B-B	White	IITA, Dent
P4	(TZMI501×KU1414×501)-1-4-3-1-B-B-B-B-B-B-B-B	White	IITA, Dent
P5	1368×ICAL224-1×1368-3-1-B-B-B-B-B-B-B-B-B-B-B	White	IITA, Dent
P6	TZL-COMP3-C2-S2-34-4-1-2-B-B-B-B-B-B-B	White	IITA, Dent

$x_{ijk} = \mu + r_i + g_j + \rho_{k(j)} + e_{ijk}$ Where , x_{ijk} = Observation of the i^{th} line and j^{th} line in the k^{th} replication, μ = The population mean, r_i = Effect of the i^{th} line due to replication , g_j =Effect of the j^{th} line due to genotype, $\rho_{k(j)}$ = Block within replicate effect, e_{ijk} =Experimental error

Table 2: Format of Analysis of Variance (ANOVA) for one location in one year

Source of variation	Df	MS	EMS
Block (rep)	b(r-1)	M_4	
Replication	$(r-1)$	M_3	
Genotype	$(g-1)$	M_2	$\sigma^2{}_e + r\sigma^2{}_g$
Error	$(g-1)\,(r-1)$	M_1	$\sigma^2{}_e$
Total	$(rg-1)$		

Where r and g are the number of replications and genotypes, respectively and σ_e^2 and σ_g^2 are error and genotypic variances, respectively, (Obi, 1986).

Results and Discussion

The result of the genotypes for agronomic and kernel quality traits at Samaru is presented in Table 3. Significant differences (p≤ 0.05) were observed among the genotypes for the following traits plant height, days to maturity, ear height, ear length, field weight, milling test and yield indicating presence of genetic variability in the genotypes This result agrees with the findings of Baqa *et al.* (2014) who reported that plant height and physiological maturity were significantly affected by the variety. According to Bello and Olaoye, (2009) the variation in cob length, number of kernel per cob, cob weight and grain yield was to be expected, as genetic composition of these materials were probably different. Percent whole kernel, percent kernel without pericarp damage, moisture content at harvest, volume and density were not significant indicating that they may be conditioned by the same genes and are genetically related for these traits. The resemblance of the genotypes for these traits is not unexpected because the source parents which mainly came from IITA, Ibadan it might be possible that the inbred are related through some of their ancestors Ibrahim (2012). The mean performance for the agronomic and kernel quality traits studied at Samaru is presented in Table 4. The genotype P5 x P6 produced the tallest plants (196.60cm) while the shortest plant height (144.40cm) was recorded in the cross P4 x P5. For days to maturity, the mean ranged from 87.0 to 92.0, P2 x P6 had the highest mean, while P1 x P2, P2 x P3 and P4 x P5 recorded the least value, and with a CV of 3.08%. The findings on days to maturity corroborates with the work of Ibrahim, (2012) who reported that days to maturity lower values of hybrids for days to maturity indicated parents were different in their genetic background, combine well to produce promising crosses for earliness. Genotype P2 x P3 produced the tallest ear (95.80cm) while the shortest ear height (70.07cm) was recorded in the cross P3 x P4. For ear length, the mean ranged from 15.43cm to 19.33cm, P1 x P2 had the highest mean while P1 x P5 recorded the least value with a CV 11.17%. For ear diameter, the mean ranged from 13.90cm to 22.30cm, P4 x P6 had the highest while P4 x P5 recorded the least value with a CV 99.99%. For field weight, P1 x P2 had the highest mean weight (4.19kg), while P5 x P6 had the lowest mean weight (2.47kg) with a CV of 20.64%. For per cent whole kernel P1 x P3 had the highest mean (69.67%) while P2 x P4 had the least mean (41.00%). For per cent kernel without pericarp damage, the mean ranged from 58.00 % to 74.67 %, P1 x P5 had the highest while P4 x P6 recorded the least value with a CV 11.82 %.. Genotype P3 x P4 had the highest mean for milling test (7.06 kg) while P3 x P6 had the least mean value (2.49 kg). For moisture content at harvest P4 x P6 had the highest mean (15.87%) while P1 x P5 had the least mean (10.73%). Genotype P1 x P4 had the highest mean for volume (24.33m^3) while P1 x P3 had the least mean value (17.33m^3). For density P1 x P6 had the highest mean (705.50kgm^{-3}) while P1 x P4 had the least mean (473.10kgm^{-3}). The findings on kernel quality traits corroborates with the work of Malvar, (2008) who reported that kernel density, per cent whole kernel, per cent kernel without pericarp damage and milling test have higher means indicating that parents were different in their genetic background, combine well to produce promising crosses for better kernel quality in maize.. For grain yield per hectare, P1 x P2 recorded the highest mean (10650kgha^{-1}) while P5 x P6 recorded the lowest mean (6265.00kgha^{-1}). The mean performance of the hybrids for grain yield per hectare recorded higher means for P1 x P2 indicating that parents were different in their genetic background and combine well to produce promising crosses for higher yield in maize . The findings on grain yield corroborates with the work (Jalal, 2003) who found that different inbred lines of maize could be combine to produce better hybrid with superior performance than their parents. This notion is in agreement with the results of the present study. This showed that this crosses received favourable gene combinations from their parents for better grain yield.

Conclusion

Variations were obtained for most of the studied traits, indicating the presence of appreciable variability in the studied genotypes, which is a key requirement in a crop enhancement programme. The result of this study also showed that hybrid crosses could be developed for specific environment as indicated by significance difference in the performance of genotype for most traits measured except ear diameter, percent whole kernel, percent kernel without pericarp damage, grain weight and volume. The overall mean performance of the genotypes signifies that there is substantial variability within the germplasm which could be used in both high yield and better quality maize breeding programs to develop suitable hybrids and varieties

Table 3: Mean square analysis for thirteen traits of maize evaluated at Samaru in 2014

Source of variation	Df	Days maturity	Plant Height (cm)	Ear Height (cm)	Ear Length (cm)	Ear Diameter (cm)	Field Weight (kg)	% whole kernel	% kernel Without Pericarp damage
Block(rep)	12	7.56	295.13	143.82	3.46	271.88	0.56	61.88	126.9
Replication	2	23.29	677.25	191.82	6.82	207.72	1.13	184.02	93.81
Genotype	24	14.41*	1027.14**	255.07**	9.94**	294.57	2.12**	153.84	89.54
Error	36	7.56	208.29	103.54	3.5	268.37	0.4	98.49	61.82

Table 3: Cont...

Source of variation	Df	Milling test	% Moisture content at harvest	Volume (m^3)	Density (kgm^{-3})	Yield ($kgha^{-1}$)
Block(rep)	12	5.62	3.74	16.41	21165.2	3629799
Replication	2	0.44	9.22	14.95	13453.2	7278278
Genotype	24	12.38**	5.86	15.07	26145.2	13701228.80*
Error	36	2.38	5.11	14.04	24489.2	2570876

Table 4: Mean Performance for thirteen traits of maize evaluated at Samaru in 2014

Genotypes	Days Maturity	Plant Height (cm)	Ear Height (cm)	Ear Length (cm)	Ear Diameter (cm)	Field Weight (kg)	% whole kernel
P1	90.33b-e	185.27a-e	84.87a-f	21.07a	61.90a	3.42b-d	47.50fg
P2	93.33ab	141.53j	68.97f	14.07f-h	10.83b	0.79f	55.67b-g
P3	90.67b-e	164.07d-j	84.50b-f	15.83c-g	13.70b	3.33b-d	62.33a-f
P4	87.33de	164.00d-j	74.77d-f	14.23f-h	12.57b	1.64ef	52.17c-g
P5	90.00b-e	147.20i-j	75.83d-f	12.93gh	13.83b	1.41f	53.50b-g
P6	95.67a	115.40k	46.93g	12.37h	10.03b	1.23f	67.00a-c
P1P2	87.00e	187.80a-d	85.50a-f	19.33ab	15.47b	4.19ab	52.33c-g
P1P3	89.00b-e	175.47b-h	76.87c-f	15.87c-g	14.03b	3.24b-d	69.67ab
P1P4	87.67c-e	178.87a-g	88.50a-d	18.60a-d	14.93b	3.25b-d	56.33b-g
P1P5	88.00c-e	154.93h-j	84.07b-f	15.43e-h	14.90b	3.04cd	61.17b-f
P1P6	88.00c-e	161.07f-j	80.40b-f	18.90a-c	15.43b	3.11cd	65.00a-d
P2P3	87.00e	190.53a-c	95.80ab	17.57b-e	14.87b	3.57bc	48.50e-g
P2P4	87.67c-e	194.00ab	83.53b-f	17.00b-f	14.20b	3.66a-c	41.00g
P2P5	88.00c-e	176.27b-h	82.93b-f	17.40b-e	14.27b	3.19b-d	59.00b-f
P2P6	92.00a-c	161.80e-j	86.93a-e	16.30b-f	14.03b	3.14cd	50.50d-g
P3P4	89.67b-e	170.00c-i	70.07f	18.30a-e	15.10b	3.24b-d	50.00d-g
P3P5	88.33c-e	185.40a-e	93.47a-c	16.60b-f	14.80b	3.08cd	63.17a-f
P3P6	90.67b-e	196.60ab	93.43a-c	16.37b-f	15.10b	3.19b-d	59.33b-f
P4P5	87.00e	144.40j	79.73b-f	17.87b-e	13.90b	3.07cd	64.50a-e
P4P6	90.67b-e	183.13a-f	94.10ab	16.53b-f	22.30b	3.64bc	59.00b-f
P5P6	91.67a-d	156.73g-j	71.63ef	15.63d-g	13.73b	2.47de	57.83b-f
Oba- 98	88.33c-e	179.33a-g	91.04a-d	16.53b-f	15.33b	3.18b-d	60.67b-f
MEANS	89.25	171.61	83.24	16.75	16.38	3.06	58.33
CV%	3.08	8.41	12.22	11.17	99.99	20.64	17.02

Table4: Cont...

Genotypes	%kernel Without Pericarp damage	Milling test	% Moisture content at harvest	Volume (m^3)	Density (kgm^{-3})	Yield ($kgha^{-1}$)
P1	68.67a-e	2.78f-h	16.67a	23.23ab	467.20c	8694.00b-d
P2	62.00b-e	2.08h	14.63a-d	18.00b-d	654.90a-c	1998.00f
P3	60.67c-e	3.06e-h	13.30a-e	13.00d	856.80a	8466.00b-d
P4	76.67a	3.82d-h	13.40a-e	20.93a-c	534.00bc	4165.00ef
P5	72.67a-d	6.98bc	13.13a-e	20.50a-c	558.50bc	3581.00f
P6	66.00a-e	11.02a	15.00a-d	19.17a-d	732.80ab	3115.00f
P1P2	72.67a-d	3.58d-h	12.80b-e	20.3a-c	571.20bc	10650.00ab
P1P3	69.33a-e	5.63b-d	12.30b-e	17.33b-d	694.10a-c	8237.00b-d
P1P4	73.33a-c	3.38d-h	13.07a-e	24.33a	473.10c	8254.00b-d
P1P5	74.67ab	2.60gh	10.73e	22.83a-c	488.60bc	7729.00cd
P1P6	62.67b-e	3.92d-h	12.33b-e	18.17a-d	705.50a-c	7898.00cd
P2P3	66.00a-e	5.11b-g	13.17a-e	23.17a-c	495.40bc	9075.00bc
P2P4	64.00a-e	3.67d-h	11.70c-e	19.17a-d	610.90a-c	9304.00a-c
P2P5	62.67b-e	2.97f-h	12.20b-e	19.67a-c	607.20a-c	8102.00b-d
P2P6	64.00a-e	5.29b-f	13.03a-e	21.93a-c	507.50bc	7966.00cd
P3P4	70.67a-e	7.06b	13.43a-e	20.20a-c	600.30a-c	8237.00b-d
P3P5	60.67c-e	2.80f-h	10.80e	18.83a-d	613.70a-c	7814.00cd
P3P6	60.00de	2.49h	13.30a-e	22.50a-c	499.40bc	8102.00b-d
P4P5	66.00a-e	4.56b-h	11.70c-e	20.17a-c	624.80a-c	7805.00cd
P4P6	58.00e	2.85f-h	15.87ab	22.67a-c	509.90bc	9236.00bc
P5P6	68.00a-e	3.59d-h	15.43a-c	21.67a-c	506.20bc	6265.00de
Oba- 98	58.00e	2.35h	13.70a-e	23.43ab	473.90bc	8085.00b-d
MEANS	66.53	4.23	13.14	20.52	581.23	7767.03
CV%	11.82	36.55	17.21	18.26	26.92	20.64

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Molecular Identification of Viruses Associated with Cassava Mosaic Disease (CMD) in Bayelsa State, South-South Nigeria

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Abstract
We report the current cassava virus status in five Local Government Areas (LGAs) in Bayelsa State. African cassava mosaic virus (ACMV) and East African cassava mosaic Cameroon virus (EACMCV) were responsible for Cassava mosaic disease (CMD) in the state. There was 100% prevalence of virus infection in all 23 fields sampled. The mean disease symptom incidence was 44.06% while the mean symptom severity was 3.23 on a 5-piont scale. The findings reveal that infection is predominantly through planting stakes (stem). This calls for the adoption of stringent control measures in exchange of planting materials amongst farmers.

Introduction
Cassava mosaic disease (CMD) is the most economically important viral disease of cassava in Sub-Saharan Africa (Legg *et al*., 2006). It is caused by cassava begomoviruses (CMBs), transmitted by whitefly, *Bemisia tabaci* from plant-to-plant. The spread of CMD occurs mostly by the distribution of infected stem cuttings. Cassava mosaic disease and Cassava Brown Streak Disease (CBSD) are virus diseases that affect cassava productivity. Although CMD is prevalent in all cassava farms in the country and causes substantial yield reduction, total loss is extremely difficult to estimate. However, CBSD can wipe out the entire cassava field resulting in 100% yield loss. This disease is presently in most parts of East and Central Africa. Therefore, for effective control and management there is the need for routine surveillance and screening for cassava viruses across the country.

Materials and Methods
A total of 960 plants in 23 fields were assessed for virus incidence in Bayelsa state in the south-south Nigeria. Of this number, 93 cassava leaf samples (70 symptomatic and 23 asymptomatic) were collected for virus indexing. The whitefly population count was based on the number on the top five expanded leaves.

Nucleic acid extraction

Total nucleic acids were extracted from 100 mg of cassava leaf by a modified Cetyl Trimethyl Ammonium Bromide (CTAB) protocol described by Abarshi *et al*. (2010).

Virus Index

Samples were indexed for viruses - *African Cassava Mosaic Virus* (ACMV), *East African Cassava Mosaic Cameroon Virus* (EACMCV), *East African Cassava Mosaic Virus Uganda* (EACMV-UG) and *Cassava Brown Streak Virus* (CBSV) with specific oligonucleotide primers previously described (Alabi *et al.,* 2008) by both PCR and RT-PCR using a thermocycler. RT-PCR products were analyzed by electrophoresis in 1% (w/v) TAE agarose gel containing ethidium bromide 0.003% (v/v). Gel was visualized under UV light.

Results and Discussion
A total of 304(44.06%) of the 960 plants accessed were affected with varying degree of virus infection. The mean CMD symptom severity and incidence of disease symptoms were 3.23 and 44.06%, respectively, while the mean whitefly population was 41.74 (Fig. 1). The implication of this is that, out of every ten samples, at least four are infected with varying degree of virus symptom. The whitefly population was generally low (Fig. 1). In fact, a location with 50% virus

symptom incidence had zero whitefly count. Thus, propagation of the virus disease is mainly through stem cuttings. The virus index result showed that ACMV and EACMCV were detected in the samples either as a single or as a mixed infection (Table 1). Of the 93 samples tested, 67 (72.04%) were infected. Of this number, 10 (14.93%) came from asymptomatic leaf samples. Symptomatic expression on cassava leaves alone may not be adequate for the selection of infected samples for diagnosis. Therefore, molecular techniques as well as selection of both symptomatic/asymptomatic leaves from various portions of the plant are necessary for adequate diagnosis and detection of cassava viruses. No EACMV-UG or CBSV was detected in all the samples.

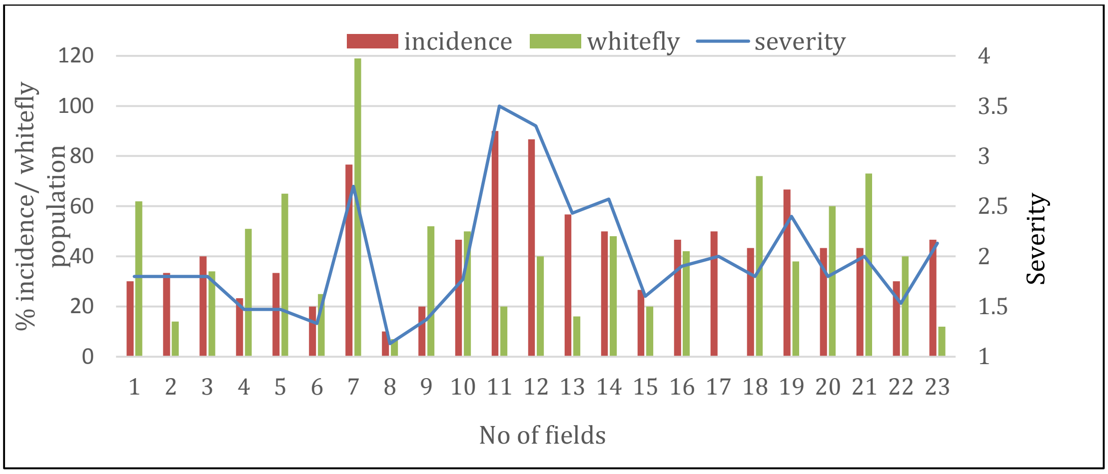

Fig. :. Virus incidence and whitefly population in fields sampled in Bayelsa State

Table 1. Virus infection in relation to the severity score

	Severity score					
Infection	1	2	3	4	5	Total
ACMV only	7	6	17	13	3	46 (49.46%)
EACMV only	2	0	0	0	1	3 (3.22%)
Mixed infection (ACMV+EACMCV)	1	2	5	7	3	18 (19.35%)
No Tested	23	21	22	20	7	67/93 (72.04%)

Conclusion

African Cassava Mosaic Virus (ACMV), *East African Cassava Mosaic Cameroon Virus* (EACMCV) are the two viruses responsible for CMD in Bayelsa state. This disease is predominantly propagated through infected plant materials (stems) and calls for a more stringent control measure. Establishment of certified Village Seed Entrepreneurs (VSEs) would serve as source of clean planting materials for farmers.

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Discrimination of Viruses Associated with Cassava Mosaic Disease (CMD) in Delta State, South-South Nigeria

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Abstract
Our study has shown that *African cassava mosaic virus* (ACMV) and *East African cassava mosaic Cameroon virus* (EACMCV) were responsible for Cassava mosaic disease (CMD) in 41fields in 12 Local Government Areas (LGAs) in Delta state. The mean disease symptom incidence was 11.14%, the mean symptom severity was 2.83 and high whitefly mean count 104.64. Although whitefly count was high, findings reveal that infection is predominantly through stem cutting. Thus, a more stringent control measures in exchange of planting materials amongst farmers shown be adopted.

Introduction
Cassava mosaic disease (CMD) is the most economically important viral disease of cassava in Sub-Saharan Africa (Legg *et al*., 2006). Over US$1.5 billion per annum has been the estimated lost due to CMD (Thresh et al., 1997). The disease is caused by cassava begomoviruses (CMBs) transmitted from plant to plant by a whitefly vector, *Bemisia tabaci*. However, the disease spread is predominantly by exchange of infected cuttings. Cassava mosaic disease and Cassava Brown Streak Disease (CBSD) are virus diseases that affect cassava productivity. While total yield loss in CMD may be difficult to estimate, CBSD can wipe out the entire cassava field resulting in 100% yield loss. This disease is presently in most parts of East and Central Africa. Thus, for effective management and control, there is the need for routine surveillance/ screening, and establishment of certified local seed entrepreneurs across the country.

Materials and Methods
A total of 1230 plants in 41 fields were assessed for virus incidence in Delta state in the south-south Nigeria. Of this number, 99 cassava leaf samples (42 asymptomatic and 57 symptomatic) were collected for virus indexing. The whitefly population count was based on the number on the top five expanded leaves.

Nucleic acid extraction
Total nucleic acids were extracted from 100 mg of cassava leaf by a modified Cetyl Trimethyl Ammonium Bromide (CTAB) protocol described by Abarshi *et al*. (2010).

Virus indexing
Samples were indexed for viruses *African Cassava Mosaic Virus* (ACMV), *East African Cassava Mosaic Cameroon Virus* (EACMCV), *East African Cassava Mosaic Virus Uganda* (EACMV-UG) and Cassava Brown Streak Virus (CBSV) with specific oligonucleotide primers previously described (Alabi *et al.,* 2008) by both PCR and RT-PCR using a thermocycler. RT-PCR products were analyzed by electrophoresis in 1% (w/v) TAE agarose gel containing ethidium bromide 0.003% (v/v). Gel was visualized under UV light.

Results and Discussion
Of the 1230 plants accessed, 139(11.3%) were affected with varying degree of virus infection. The mean virus disease symptom incidence and severity were 11.14% and 2.83 on a 5-piont scale respectively, while the mean whitefly population was 104.64 (Fig. 1). The implication of this is that, out of every ten samples, at least four are infected with varying degree of virus symptom. The whitefly population was generally high (Fig. 1). In fact, all the fields, 13 (31.71%) with no

virus disease incidence had whitefly counts. Thus, there appears to be no relationship between whitefly population and virus incidence, rather susceptibility to virus infection is on varietal basis. The virus index result showed that ACMV and EACMCV were detected in the samples either as a single or as a mixed infection (Table 1). These two viruses have been reported in CMD infected cassava plants in West Africa. Of the 99 samples tested,40 (40.4%) were infected. Of this number, 2 (5%) came from asymptomatic leaf samples. No CBSV or EACMV-UG was detected in all the samples. Therefore, for effective discrimination of viruses, a combination of molecular techniques and selection of both symptomatic/asymptomatic leaves from various portions of the plant is necessary.

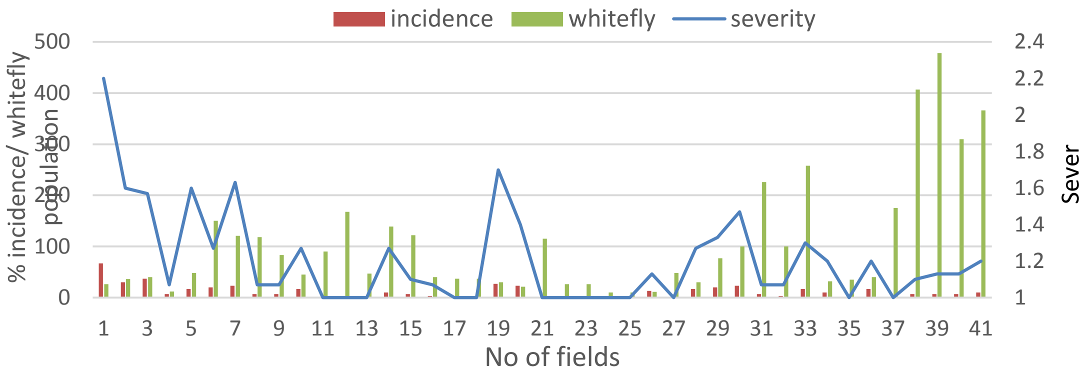

Fig. 1: Virus incidence and whitefly population in fields sampled in Delta state

Table 1: Virus infection in relation to the severity score

Infection	Severity score					Total
	1	2	3	4	5	
ACMV only	2	2	20	3	0	27 (27.27%)
EACMV only	0	0	2	1	0	3 (3.03%)
Mixed infection (ACMV+EACMCV)	0	1	3	3	3	10 (10.1%)
No Tested	42	22	25	7	3	40/99 (40.4%)

Conclusion

Virus index analysis has implicated *ACMV* and *EACMCV* as the viruses associated with CMD in Delta state. These two viruses are the cause of CMD in Nigeria. Results have also shown that there is no EACMV-UG and CBSD in Delta, however, there is the need for establishment of proper seed certification system for clean seed production for farmers.

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Microbes Revolution: A Biological Approach towards Profitable And Sustainable Agriculture

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Abstract
As the world population growth is predicted to swell-up to about 9.3 billion by 2050, the need to significantly increase agricultural food production without increasing much pressure on the environment throws up a challenge to researchers especially in the field of soil and microbial ecology. Microbial solutions could enhance farmer's agricultural yield and productivity in a sustainable way. To accomplish this objective researchers are looking beyond the conventional methods but are now tapping into the beneficial effects of microbes on plant growth which includes nitrogen fixation, nutrient acquisition and uptake, enhancement of shoot and root growth, disease suppression and improved soil structure for a profitable sustainable crop production.

Introduction
In the beginning agriculture was based on incorporating nitrogen fixing legumes and pulse crops into management practices by our primitive but foresighted farmers. Recently economic cost and environmental impacts of synthetic nitrogen fertilizers and pesticides are increasingly making these previously abandoned biological approaches more attractive to farmers. The year 2000, marked a new beginning towards doubling food production in a more sustainable fashion with reduced pressure on available resources. But one major challenge that is facing the entire world is on how to feed the ever-increasing human population of about 9.3 billion by 2050. (www.unfpa.org). Naturally, plants depend on microbes in the soil for the maintenance of their health and vigour. Like plants, we depend on a large number of microbes to digest our food, regulate our systems and to suppress some deadly pathogens. To achieve this goal, scientists are now looking beyond the conventional methods of crop production. They are now refocusing their thoughts and energies on microbial activities in the soil for inspiration on sustainable agricultural future. The authors now narrows down on the three major groups of microbes that are considered to be the architects of soil fertility, plant health, soil structure and disease suppression. Among them is nitrogen fixing rhizobia that are principally involved in biological nitrogen management that provides crops with nitrogen at the right time as well as avoiding nitrogen depletion and pollution. Beside nitrogen fixation, arbuscular mycorrhizal fungi (AMF) is one of the most ancient and pervasive microorganism that has evolved for over a period of 460 million years with the majority of land plants. This AMF forms extensive hyphal networks in soil and provide the plant with nutrients in exchange for photosynthates (Smith and Read, 1997). Also of importance are **s**ome of the frequently useful beneficial microbes in agriculture globally. One such alternative is the biocontrol of pests and diseases by some microbes including *Bacillus*, *Trichoderma*, *Pseudomonas*, *Streptomyces*, and many other species. These microbes due to their eco-friendliness and specificity are preferred over chemical pest and disease management practices. This new approach is to take advantage of what nature has already provided – the ubiquitous and amazing world of microbial community (Ubalua *et al.*, 2017). In addition, recent breakthroughs in low-cost DNA sequencing and other technologies have opened up the secret world of these microbes. This development has provided the possibility of identifying almost every member of the microbial community that makes up the plant microbiome, leading to an emerging understanding of how various microbes behave in different seasons and soil environments with the possibilities of tweaking them to help plants grow better (How microbes can help feed the world, 2012).

N_2-fixing Rhizobia

Legumes such as soybeans, beans, peanuts etc are already enjoying comfortable symbiotic relationship with N_2-fixing root microbes including *Rhizobium*, *Azospirillium*, *Mesorhizobium, Azotobacter* etc. In nature, nitrogen-fixing rhizobia that live within the roots of legumes can utilize the enormous amount of atmospheric nitrogen by converting them to an organic form that plants can use. According to Amaranthus and Simpson, 2011), a legume cover crop can add and store as much as 200 pounds of nitrogen in an acre of soil. To initiate the process, the leguminous plant attracts nitrogen-fixing bacteria to invade the cells in the root and provides them with carbohydrates as a food source while the bacteria reduce nitrous compounds in the soil that are then used by the plant (Morrissey *et al*., 2004). Figure 1A to D shows nodules on beans roots and nodules cut open to show reddish-pink colour indicating that the nodules are active and healthy after 12 weeks of planting. Apart from nitrogen fixing rhizobia, *Azotobater* is another available alternative to chemical fertilizer. This bacterium is a free-living nitrogen-fixer that has multiple beneficial effects on crop growth and yield by synthesizing growth regulating substances like auxins, cytokinin and Giberellic Acid (GA). It also stimulates rhizospheric microbes, protects the plants from phyto-pathogens, improves nutrient uptake and ultimately boost up biological nitrogen fixation (Jnawali *et al*., 2015). The attraction in exploiting the potentials of *Azotobacter spp*. in agriculture lies in their ability to utilize atmospheric nitrogen gas for the cell protein synthesis which is mineralized in soil after death, thereby contributing towards nitrogen availability of crops. It therefore implies that *Azotobacter* can be an important alternative to synthetic fertilizer and is capable of fixing an average of 20 kg N/ha per year (Jnawali *et al*., 2015). Additionally, *Azotobacter* inoculants has been associated with enhanced effect on growth parameters like root, shoot length and dry mass of maize seedlings *in vitro* and in pot experiments (Salhia, 2013). Thus, biofertilizers are economical, safer, self-replicating, and target specific, while chemical fertilizers are expensive and also induces adverse effect on soil health and microbial population.

Fig. 1A, B & C: Nodules on bean roots. 1D: Nodules from bean roots cut open to show the reddish-pink colour that indicates active healthy nodules.
Photo by Dr. Alfred O. Ubalua, NRCRI Umudike, Umuahia, Nigeria.

Biological control

The rhizosphere is the interface between plant roots and the soil and accounts for multiples of microbial activities compared to those in the bulk soil. Among the micro-organisms interacting with plant roots in the rhizosphere, are the beneficial microorganisms such as *Bacillus*, *Pseudomonas*, *Trichoderma* and arbuscular mycorrhizal fungi (AMF). The inherent two-way traffic pathway that exists between plant roots and microbial population in the rhizosphere has important ecological implications for soil function, including biogeochemical cycles, plant health and productivity. One unique and discernible benefit for the plant is a better supply of and access to nutrients. Services provided by these soil microbes are critical for plants health and survival. In their natural environment, plants depend on microbes for optimization of their growth and survival. They live in and on their roots, stems, leaves, and other plants parts (How microbes can help feed the world, 2012). These microbes support plant health by increasing the availability of nutrients, enhancing plant root growth, neutralizing toxic compounds in the soil, making plants more resistant to diseases, heat, flooding, and drought and deterring pathogens and predators (How microbes can help feed the world, 2012). Soil beneficial microbes also play significant roles in the conservation, mobilization and transportation of nutrients from soil into plants. In addition to enhancing the nutrient supply of plants, they also confer a degree of protection against plant diseases (Ubalua *et al*., 2017). A unique phenomenon where microbes protect against phytopathogens is biological control. Typical example includes various bacteria and fungi, especially of the genera *Pseudomonas*, and *Trichoderma* that produces a range of metabolites against other phytopathogenic fungi and can actively antagonize or destroy other pathogens in our agricultural crops (Bloemberg and Lugtenberg, 2001, Raijaamkers *et al*., 2002). Others are the soil bacterium *Bacillus thuringiensis* (Bt) that produces insect killing toxins (How microbes can help feed the world, 2012). For example, Table 1 shows some beneficial organisms that are commonly used globally in crop production.

Table 1: Some beneficial organisms with demonstrable functions in disease suppression

Organisms	Functions
Bacillus spp.	Competition, parasitism and predation
Pseudomonas brassicacearum	Parasitism
Pseudomonas fluorescens	General antibiosis
Streptomyces spp.	Prevent access to infection sites
Trichoderma spp.	Metabolites/disrupt plant-microbe signaling
Penicillium griseofulvum	General antibiosis

Condensed from: Vadakattu, V.S.R.G, Microbiology Australia, 2012

Arbuscular mycorrhizal fungi (AMF)

Mycorrhizae are not new. This 'symbiotic' association between the fungus and plant roots dates back since over 460 million years. In an undisturbed natural habitat, mycorrhizae proliferate on plants roots and spread into the surrounding soil as a network of tiny absorptive hyphae. Through this union, plants use their photosynthetic leaves to meet mycorrhizae carbon needs in exchange for nutrients especially phosphorus and water from the mycorrhizae (Amaranthus & Simpson, 2010). Mycorrhizal fungi are the major reason why our natural habitats are healthy and productive without artificial inputs of synthetic fertilizers and irrigation. Hence, cropping systems could be more sustainable by managing mycorrhizal fungi for increased yields and enhanced efficiencies (Amaranthus & Simpson, 2012, Ubalua *et al*., 2017). Another significant contribution of mycorrhizae to soil and agricultural practice is carbon sequestration through their hyphae. Carbon is composed of up to 30-40 percent of the glomalin molecule. Apart from the generous contribution of carbon to the soil by glomalin, it also functions as a kind of "soil superglue" helping to bind soil particles together into tiny aggregates. These aggregates hold moisture and improve tilt, making soil more loamy, nutrient-rich and less subject to erosion. But beyond nutrient and mineral acquisition, mycorrhizal fungi are also implicated in plant natural defense against fungal root diseases such as *Phytophthora*, *Fusarium, Pythium* and *Rhizoctonia*. They produce and release suppressive exudates such as antibiotics that prevent infection by these organisms and other fungal root pathogens. Their further defenses also include formation of a physical barrier made of chitin to deter invasion by soil pathogens (Amaranthus & Simpson, 2010).

Conclusion

Optimizations of plant-microbiome interactions can substantially reduce the need for synthetic fertilizers and pesticides. Application of microbial techniques in crop production has been predicted to increase crop yield by 20% while reducing fertilizer and pesticide requirements by 20% within the next 20 years. This approach in combination with some new technologies could produce dramatic benefits and may precipitate the 2nd Green Revolution.

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Growth and Yield of Watermelon (*Citrillus lanatusL*) as Influenced by Planting Spacing and Mulching in Lafia, Nasarawa State

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Abstract
Field experiment was conducted during the rainy seasons of 2016 and 2017 at the Teaching and Research Farm of the Faculty of Agriculture, Nasarawa State University, Keffi, Lafia Shabu Campus to determine the effects of varying planting spacing (50x50cm, 50x100cm and 100x100cm) and mulching materials (control, rice husk and dry grass) on the growth, yield and yield characters of watermelon. The nine treatment combinations were laid out in a randomized complete block design (RCBD) with four replications. The results of the study indicated that all the growth and some yield characters measured (vine length, number of branches and number of leaves per plant, number of marketable fruits, fruit length and fruit diameter) were significantly increased by a planting spacing of 100 x 100cm compared to other planting spacing (50x50cm and 50x100cm). The number of fruits per hectare and fruit yield (t/ha) were significantly increased by a planting spacing of 50x50cm compared to other spacing. All the growth yield and yield characters of watermelon measured (vine length, number of branches, number of leaves, number of marketable fruits per hectare number of fruit per plant, fruit length, fruits diameter, number of fruits per plant, and fruit yield per hectare) were significantly increased by using rice husk as mulching material compared to using dry grasses and no mulch (control). For effective production of watermelon that will translate to higher marketable yield, a spacing of100x100cm and rice husk as mulching material should be adopted.

Introduction
Watermelon; (C*itrulluslanatus*(Thum.) Matsum and Nakai) belongs to the family of *Cucurbitaceae* (Schippers, 2000).). It is an annual plant with long weak vine-like (trailing) stems of 3m (10 ft.) long. Watermelon is thought to have originated in the Kalahari Desert of Africa. The first recorded watermelon harvest occurred nearly 5,000 years ago in Egypt and is depicted in Egyptian hieroglyphics on walls of their ancient buildings. It is known for its highly nutritious edible fruit, which is one of the world most important vegetable crops, grown extensively in more than 96 countries worldwide. In 2016, global production of watermelons was 117 million tonnes, with China alone accounting for 68% of the total (FAOSTAT, 2017). Secondary producers with more than 1% of world production included Turkey, Iran, Brazil, Uzbekistan, Algeria, the United States, Russia, Egypt, Mexico, and Kazakhstan. Watermelon is not only made up of water and sugar but it is also a nutrient based food as it contains high amount of vitamins, minerals and antioxidants. It also contains niacin, thiamin, vitamin B-6, zinc, magnesium and many more nutrients that are good for one's health. There are many health benefits of Watermelon as it is low in calories so it promotes phyto-nutrients and anti-oxidants essential for the optimization of health. It also helps in the prevention of Asthma as it possess high amount of nutrients. Because of its healthy fiber and water content, it helps in prevention of constipation and there are many more benefits of the fruit (Linnewiel *et al.,* 2009). Manipulation of agronomic factors such as row and plant spacing may provide a non- chemical means of reducing the impact of weeds interference on crop yields (Buhler, 2002), a key component of alternative approaches to weed management is the enhancement of crop competitiveness against weeds (Watson and Weise, 1991). Closer rows and high plant population reduced the evaporation, increased efficiency of

water higher growth and yield by increasing the energy available to crop (Walker and Buchanan, 1981). Mulching in general is a beneficial practice for crops to increase vegetable production technique that involved placement of organic or inorganic materials on the soil surface to provide favorable environment for plant growth and development. Mulch alter soil temperature and moisture condition, which in turn may affect plant growth yield and fruit quality (Korir, 2006). Marketable yield from the mulched treatments were higher than those produced on bare soil, Farios-Larios & Orozco-Santos, 1997). Mulching vegetables can increase yields promote early harvest and reduce fruit defects. Moreover, mulches can reduce evaporation from the soil surface, prevent weed growth, modify soil temperature, reduce costs, protection of soil structure, and reduce insect number (Ekinci and Dursun, 2014). In this agro ecology, farmers produce watermelon, but unfortunately not all the fruits produced are of marketable value, due to non-adherence to correct planting spacing and the high heat emanating from the soil that destroyed the fruits before ripening. Adoption of correct planting spacing and mulching will help produce fruits that are of marketable quality, optimum plant population will be realized and the effect of high temperature that destroy the fruits before ripening will be avoided. There is paucity of information on the effects of spacing and mulching on the growth and yield of watermelon particularly in this agro ecology. This work, therefore, seeks to evaluate the effects of planting spacing and mulching on the growth and yield of watermelon.

Materials and Methods

Field experiment was conducted for two years during the dry seasons of 2016 and 2017 at the Teaching and Research Farm of the Faculty of Agriculture, Nasarawa State University, Keffi, Shabu –Lafia Campus (8^0 34′ N and 80 33′E) to determine the effects of planting spacings ($50\times 50cm, 50\times 100cm, 100\times 100cm$) and different mulching materials (rice husk, dry grasses and the control) on the growth and yield of watermelon. The nine treatment combinations were laid out in Randomized Complete Block Design (RCBD) with four replications. The gross plot size was $16m^2$ (4m x 4m) while the net plot size was $9m^2$ (3mx 3m). The experimental area was harrowed followed by construction of seed beds. Between each plot was an unplanted border of 1m while between each replication, there was an unplanted border of 2m. Poultry manure (5 tons ha^{-1}) was incorporated into all the seed beds and left for 2 weeks before planting to reduce the scotching effect of the poultry manure on the seeds. Sowing was done on seed bed at 50cmx50cm, 50cmx100cm and 100cmx100cm planting spacing according to field plan and treatment combinations. Different mulching materials were applied to the experimental beds according to treatment plan at two weeks after sowing (2WAS). All other good cultural practices required for higher yield were strictly followed. Growth parameters such as vine length, number of branches per plant, number of leaves per plant were assessed at 4, 6, 8 and 10 weeks after sowing on 5 randomly selected tagged plants in each plot. Vine length was measured by using a flexible measuring tape. Number of leaves was assessed by visual count of the functional leaves on the randomly selected tagged plants and the mean recorded. Number of branches was taken by visual count of the branches on the randomly selected tagged plants and the mean recorded. At every harvest, fruit diameter was assessed by using a Vernier calliper; the fruit length was measured by using a flexible tape before the fruits were weighed using a Salter scale. Number of fruits per plant was assessed by counting the number of fruits from the randomly selected tagged plants and the mean recorded. Numbers of marketable tubers from each net plot were selected, counted and value obtained converted to per hectare basis. The fruits from each net plot were weighed and the value obtained was converted to per hectare basis to give fruit yield per hectare. The data collected were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1990) and significant differences among the treatment means were evaluated using Duncan's Multiple Range Test as described by Duncan (1955).

Results and Discussion

Results of the physic-chemical properties of the experimental soil before and after the experiment revealed that before the experiment, the soil was sandy, low in organic matter, organic carbon, Magnesium and moderately acidic. After the experiment, plots to which rice husk and grass hays were added as mulching materials had slight increase in organic matter, organic carbon, Magnesium and slight increase in pH (Table 1). Plots to which watermelon were planted at 100 x 100cm and mulched with rice husk produced significantly longer vines at all sampling periods compared to other planting spacing and mulching material used (Table 2). Significant interaction occurred between spacing and mulching on the vine length of watermelon at 10 WAS. The result of the interaction showed that holding the spacing constant and varying the mulching materials from the control, dry grass to rice husk significantly increased vine length. Similarly holding mulching material constant and varying the spacing significantly increased the vine length of watermelon. The longest vine was produced at 100x100cm spacing with rice husk as mulching material (Table 3). Planting of watermelon at a spacing of 100x100cm produced significantly higher number of branches compared to other planting spacing (50x50cm and 50x100cm) at all sampling periods. Plots that were mulched with rice husk had plants with significantly higher number of branches compared to those mulched with dry grass and the control at all sampling periods (Table 4). Significant interaction occurred between spacing and mulching on the number of branches at 10 WAS. The result of the interaction showed that holding the spacing constant and varying the mulching materials from the control, dry grass to rice husk significantly increase branch number. Similarly holding mulching material constant and varying the spacing significantly increases the number of branches (Table 5). Table 6 shows the effects of spacing and mulching on the number of leaves per plant at 4, 6, 8, and 10 WAS. The results obtained indicated that at 4 WAS, neither spacing nor mulching had any significant effect on the number of leaves. At 6, 8 and 10 WAS, spacing of 100x100cm produced plants with significantly higher number of leaves compared to other spacing used. Mulching of watermelon with rice husk produced significantly higher number of leaves compared to plots that were mulched with dry grasses and control at all sampling periods. Planting watermelon at 100x100cm spacing significantly produced higher numbers of marketable fruits per hectare, longer, wider, and higher number of fruits per plant compared to those plots planted at 50x50cm and 50x100cm spacing. Fruit yield per hectare was significantly increased by planting at 50x50cm followed by 50x100cm and 100x100cm spacing respectively (Table 7). Using Rice husk as mulching materials significantly produced fruits that were longer, wider, higher number of fruits per plant and fruit yield (t/ha) compared to plots that were mulched with dry grass and control. Significant interactions occurred between spacing and mulching on number of marketable fruits per hectare and fruit yield per hectare. The results of the interaction between spacing and mulching on the number of marketable fruits per hectare showed that the highest numbers of marketable fruits were obtained by planting watermelon at 100 x 100cm and applying rice husk as mulching material (Table 8). Results of the interaction between spacing and mulching on the fruit yield tons per hectare showed that planting watermelon at a spacing of 50 x 50cm and using rice husk as mulching material, produced significantly the highest fruit yield tons per hectare (Table 8).

The results of this study showed that the growth characters of watermelon were significantly improved at virtually all sampling period by planting at a spacing of 100x100cm could be attributed to less competition for water, nutrient and light between crops which allow the plant to efficiently utilize the available soil nutrient and water compared to other spacing used for effective growth and development. Though fruit yield (t/ha) and number of fruits per plant were significantly increased by planting spacing of 50x50cm compared to other spacing, significantly wider, longer and number of marketable fruits were produced under 100 x 100cm planting spacing. This could be attributed to the fact that at a spacing of 50 x 50cm, more fruits were produced due to increased plant population that translated to higher yield tons per hectare but at 100 x 100 the fruits were bigger thereby making them to have more marketable value compared to those produced at 50 x 50cm. The significant increase in all the growth and yield character of watermelon considered in this study (number of branches, fruits number, fruit diameter, number of leaves, vine length, fruit length, and fruit yield per hectare) due to application of rice husk as mulching material followed by dry grass mulch compared to control plot could be attributed to the fact that mulching improves the ecological environment of the soil, increases soil water contents, reduces infiltration rate, decomposes and add nutrients to the soil, control erosion and weeds problems, thereby translating to higher growth and yield. This is in line with the findings of Khurshid *et al.,(*2006). The significant interaction between spacing and mulching on most of the growth and yield characters measured is an affirmation of the fact that both are necessary for crop growth and yield.

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Table 1: The physiochemical properties of experimental site before and after the experiment

Soil characteristics	Before	After
Particle size (%)		
Sand	89.8	89.8
Silt	3.4	1.4
Clay	6.8	8.8
Bs (%)	87.5	89.8
Textural class	Sand	Loam sand
Chemical composition		
pH	6.3	6.9
Organic Carbon (%)	1.19	1.40
Organic matter (%)	2.05	2.40
Total N (molkg$^{-?}$)	39.38	0.06
Available P (PPM)	0.42	0.11
Ca (molkg^{-1})	3.50	3.62
Mg (molkg^{-1})	1.87	2.03
K (molkg^{-1})	0.18	0.01
Na (molkg^{-1})	0.29	0.26
Exchangeable acidity (molkg^{-1})	0.83	0.16
CEC (molkg^{-1})	6.67	8.40

Table 2: Effects of spacing and mulching on Vine Length (cm) of watermelon at 4, 6, 8 and 10 WAS. Data pooled 2016 - 2017

Treatment	4	6	8	10
Spacing (cm)				
50x50	99.1^{c}	184.2^{c}	214.1^{c}	238.6^{c}
50x100	109.9^{b}	199.0^{b}	247.1^{b}	258.9^{b}
100x100	124.8^{a}	221.7^{a}	267.1^{a}	287.4^{a}
SE±	0.08	0.08	0.09	0.07
Mulching (M)				
Rice husk	133.3^{a}	237.6^{a}	266.8^{a}	289.2^{a}
Dry grass	110.7^{b}	202.4^{b}	244.1^{b}	263.3^{b}
Control	87.8^{c}	165.0^{c}	217.4^{c}	232.4^{c}
SE±	0.08	0.08	0.09	0.07
Interaction				
MxS	NS	NS	NS	**

Means followed by the same letter (s) within the same column or treatment group are not statistically different at 5% level of significance.
NS= Not significant. ** Significant at 1% level of significance.

Table 3: Interaction between spacing and mulching on the vine length of watermelon at 10 WAS. Data pooled 2016 - 2017

Spacing (cm)		**Mulching**	
	Control	**Dry grass**	**Rice husk**
50x50	211.0h	243.3e	261.4d
50x100	230.5g	263.0d	283.3b
100x100	255.8c	283.6b	322.9a
	SE± = 0.022		

Means followed by the same letter (s) within the scene column or treatment groups are not statistically different at 5% level of significance.

Table 4: Effects of spacing and mulching on number of branches (cm) of watermelon at 4, 6, 8 and 10 WAS. Data pooled 2016 - 2017

Treatment	4	6	8	10
Spacing (cm)				
50x50	5.7^{c}	7.7^{c}	8.9^{c}	10.4^{c}
50x100	7.1^{b}	8.6^{b}	10.8^{b}	12.0^{b}
100x100	8.8^{a}	11.5^{a}	13.2^{a}	14.4^{a}
SE±	0.08	0.12	0.07	0.09
Mulching (M)				
Rice husk	9.7^{a}	11.9^{a}	13.7^{a}	15.0^{a}
Dry grass	7.1^{b}	9.0^{b}	10.9^{b}	12.1^{b}
Control	4.8^{c}	6.8^{c}	8.4^{c}	9.8^{c}
SE±	0.08	0.12	0.07	0.09
Interaction				
MxS	NS	NS	NS	**

Means followed by the same letter (s) within the same column or treatment groups are not statistically different at 5% level of significance.
NS= Not significant. ** Significant at 1% level of significance.

Table 5: Interaction between spacing and mulching on branch number of watermelon at 10 WAS

Spacing (cm)	mulching		
	Control	dry grass	rice husk
50x50	7.7h	10.7f	12.9d
50x100	9.8g	11.6e	14.7b
100x100	11.9e	13.9c	17.5a
	SE± = 0.29		

Means followed by the same letter (s) within the scene column or treatment groups are not statistically different at 5% level of significance

Table 6: Effects of spacing and mulching on number of leaves (cm) of watermelon at 4, 6, 8 and 10 WAS. Data pooled 2016 - 2017

Treatment	4	6	8	10
Spacing(cm)				
50x50	49.3^{c}	105.1^{c}	144.7^{c}	173.0^{c}
50x100	66.5^{b}	116.6^{b}	156.1^{b}	188.7^{b}
100x100	78.0^{a}	141.8^{a}	166.7^{a}	202.8^{a}
SE±	0.07	0.05	0.08	0.08
Mulching (M)				
Rice husk	80.0^{a}	152.4^{a}	175.3^{a}	217.9^{a}
Dry grass	66.2^{b}	114.3^{b}	158.0^{b}	183.9^{b}
Control	47.5^{c}	96.8^{c}	134.1^{c}	163.0^{c}
SE±	0.07	0.05	0.08	0.08
Interaction				
MxS	NS	NS	NS	**

Means followed by the same letter (s) within the same column or treatment groups are not statistically different at 5% level of significance.
NS= Not significant. ** Significant at 1% level of significance.

Table 7: Effects of spacing and mulching on fruits length, fruit diameter, number of fruit per plant, number of marketable fruits per hectare and fruit yield (t/ha). Data pooled 2016 - 2017

Treatment	Fruit length (cm)	Fruit diameter (cm)	Number of fruit per plant	Number of marketable fruits ha^{-1}	Fruit yield tons ha^{-1}
Spacing (cm)					
50 x 50	29.9^{c}	56.9^{c}	1.3^{c}	14444.4^{b}	85.5^{c}
50 x 100	33.9^{b}	62.1^{b}	1.6^{b}	17901.2^{a}	70.0^{b}
100 x 100	39.7^{a}	72.5^{a}	2.1^{a}	18395.1^{a}	58.3^{a}
SE$\pm$	0.41	0.07	0.04	585.22	0.07
Mulching					
Control	28.9^{c}	57.3^{c}	1.3^{c}	13950.6^{c}	59.2^{c}
Dry grass	33.7^{b}	64.0^{b}	1.6^{b}	16790.1^{b}	69.1^{b}
Rice husk	40.8^{a}	70.2^{a}	2.1^{a}	20000.0^{a}	85.5^{a}
SE$\pm$	0.41	0.07	0.04	585.22	0.07
Interaction					
S X M	NS	NS	NS	**	**

Means followed by the same letter (s) within the scene column or treatment groups are not statistically different at 5% level of significance.

Table 8: Interactions between spacing and mulching on number of marketable fruits per hectare and fruit yield (t/ha). Data pooled 2016 - 2017

	Number of marketable tubers per hectare			**Fruit yield tons per hectare**		
	Mulching			**Mulching**		
Treatment	**Control**	**Dry grass**	**Rice husk**	**Control**	**Dry grass**	**Rice husk**
Spacing (cm)						
50 x 50	69.7d	82.1b	101.7a	28518.5c	21481.5d	16296.3h
50 x 100	60.4e	68.6d	81.1b	34074.7b	26296.3cd	18518.5f
100 x 100	47.6h	56.6g	70.8c	43703.1a	32962.0b	28148.2c
SE$\pm$		0.624			222.56	

Means followed by the same letter (s) within the scene column or treatment groups are not statistically different at 5% level of significance.

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Evaluation of Ecological Impacts of Glyphosate Herbicide in Ishiagu, Ebonyi State, South-East Nigeria

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Abstract
A study was conducted to assess the ecological impact of glyphosate herbicide in the FADAMA rice plain of Amaeze Ishiagu, Ebonyi State using some indicator species as termite termitereau count, earthworm abundance, fungi microbial load and plant species. Data generated on insect: termite, earthworm, and microbial load counts were subjected to statistical analysis using students T- test, while vegetation analysis was evaluated using index of similarity analysis. Results revealed significant difference (P<0.05) between unsprayed and sprayed plots and indicated that earthworms, termite number and fungal load were more in unsprayed fields than sprayed plots. Similarly, index of similarity showed disparity exist between unsprayed and sprayed plots, and revealing that unsprayed plots with less species recorded more total plant abundance than sprayed areas. This is therefore an indication than sustained glyphosate used in the study area has impacted negatively in biodiversity depletion. To ameliorate the situation and enhance biodiversity conservation interest needs to be stimulated by stakeholders on alternative methods of vegetation management involving integrated weed control that will incorporate cultural, biological, organic herbicides, mechanical vegetation control and other non-chemical control measures.

Introduction
Pesticides are chemical substances widely used in agricultural production to prevent or control pests, diseases, weeds and other plant pathogens in an effort to reduce or eliminate yield losses and maintain high product quality. They are also used for “commercial products” applied in the control of pests, diseases and/or weeds (Hayes, and Laws, 1991). Pesticides have been used for many years in the control of organisms that interfere with human interests. From this point of view, pesticides can be considered as an economic, labor-saving, and efficient too of pest management with great popularity in most sectors of the agricultural production. Most common pesticides include insecticides, fungicides, herbicides et cetera. The use of herbicides to control the spread of obnoxious weeds is an example of a pest control method. Herbicides also commonly known as weed killers, are pesticides used to kill unwanted plants (Kellog *et al;* 2000). Herbicides are widely used in agriculture and landscape turf management in the United State, they account for about 70% of all agricultural pesticide use (Kellog *et al*; 2000). Selective herbicides kill specific targets, while leaving the desired crop relatively unharmed. Some of these act by interfering with the growth of the weed and are often synthetic mimics of natural plant hormones. Herbicides used to clear waste ground, industrial sites, railways and railway embankments are not selective and kill all plant materials with which they come into contact. Smaller qualities are used in forest, pasture system, and management of areas set aside as wildlife habitat. Glyphosate is a non-selective systemic herbicide that is applied directly to plant foliage (Tomlin, 2006). As reported by RED facts (1993) when used in smaller qualities, glyphosate can act as a plant growth regulator. Glyphosate is a glycine derivative (Tomlin, 2006). The International Union of Pure and Applied Chemistry (IUPAC) name for glyphosate is N-(*Phosphonomethyl*) glycine. Glyphosate’s potential as an herbicides was first reported in 1971 (Herbicides Handbook, 2002). Roundup herbicide Bulletin (1980) reported that glyphosate was

first registered for use by the United States Environmental Protection Agency (USEPA) in 1974. Glyphosate is one of the most widely used herbicides with applications in agriculture, forestry, industrial weed control, lawn, garden and aquatic environments (RED, 1993; RED facts, 1993). Glyphosate is absorbed across the leaves and stems of plants and is trans-located throughout the plant. It concentrates in the meristem tissue. Williams et al; (2000) equally established that glyphosate is assimilated by leaves and other green plant tissues and is then rapidly trans-located within the phloem throughout the entire plant including its roots. Giesey *et al*; (2000) stated that glyphosate based herbicides are among the most widely used broad-spectrum herbicides in the world because they are highly efficacious, cost effective and readily degradable in the environment. They maintain that the most popular formulation, roundup is a combination of the active ingredient (glyphosate) and surfactant (*polyethoylated tallowamine*) that help the herbicide penetrate plant tissues. Their uses have adverse effect on ecosystem and have the potential to cause dramatic changes in the natural communities. Ecosystem we know is the interaction between and within the living (biotic) and non-living (abiotic) components of the environment in any given habitat. All components help in the maintenance of stability and balance of the system. For this, there is no component that is importance can easily be overlooked. Removal and abnormal increase of any component will affect the stability of others and the entire ecosystem because all natural resources are interdependent and interrelated. Despite these adverse effects of the use of herbicides in agricultural production, farmers all over the world still use them as major control practice (Briggs, 2002); which farmers in Amaeze Ishiagu, Ebonyi State are not exceptions. The Amaeze Ishiagu community is noted for rice production, and it is established that most farmers in this location make use of glyphosate based herbicides to clear the vegetation of their rice fields for cultivation and other weed control practices. They apply these chemicals year after year despite variations observed in production (yields), their satisfaction being reduced cost of labour associated with the use of this herbicide to clear farm vegetation. The incessant use of the glyphosate herbicide may be as a result of non-existence of more efficient, effective and readily available alternatives.

Their wide spread use and regular application, however has caused lots of negative effects, which ranges from contamination of air, soil, water to its effects on living organisms-plants and animals (Brady,1996). It is believed that agro-chemicals affect soil micro-organisms hence the fertility of the soil, quality of water and air. Schroll *et al*; (1994) stated that concentrations of herbicides (glyphosate) on plant tissues can eliminate plant species or reduce their abundance. Furthermore, Steven and Randal (2004) reported that repeat treatment using glyphosate strongly reduced vegetation to zero at 0.14kg/hectare. Relyes (2004) revealed that widespread mortality of earthworms and other soil micro-organisms were as a result of the herbicide glyphosate. Henry *et al*; (1994) stated that glyphosate exposure caused a decrease in survival of soil termites and other soil inhabiting organisms. Herbicides reduced floral and faunal diversity and bring about instability in the ecosystem. The conservation of biological diversity (biodiversity) is becoming an integral part of the sustainable management of forest and agro-ecosystem. In this regard, vegetation management which includes chemical weed control is vital because of its widespread use and contribution to environmental degradation. Therefore, the result of this negative effect of the misuse of herbicides on our crop and environment have resulted in research into ways of reducing pesticide use and the need to properly evaluated the level of damage to the ecosystem. It is believed that chemical industries in-spite of being aware of the implications of pesticides are not giving due regard to the promotion of ecological sound practices and environmentally compatible product. In-spite of the upsurge in the use of pesticides in developing countries, there has been little or no awareness among the users of the hazards to the ecosystem. For many decades, there has been misused of herbicides without adequate information on their impact on the tropical environment. This research was envisaged to investigate the ecological impacts of glyphosate based herbicides in the FADAMA rice plain of Amaeze Ishiagu, Ebonyi State Nigeria using some indicator species.

Materials and Methods

Experimental Site

The experiment was conducted in the FADAMA rice plain consisting of strips of rice fields in Amaeze Ishiagu, Ivo Local Government Area of Ebonyi State, and South-East Nigeria. In this location, rice over the years has been intensively cultivated and glyphosate based herbicides used by most farmers in the clearing of vegetation and/or control of weeds. Ishiagu is in a derived savannah belt of South-East agro- ecological zone of Nigeria. It lies between latitude 5^0 56' longitude 7^0 31'E and has an altitude of 150m with an annual rainfall ranging from 1200mm-2000mm. The layout of the experiment consisted of ten (10) marked plots of glyphosate herbicide sprayed areas and ten (10) plots of adjacent unsprayed fields, thus giving a total of twenty (20) experimental units used for the investigation. The number of indicator species of organisms that were reduced, depleted or became extinct as a result of sustained herbicides (glyphosate) use were assessed in ten (10) marked plots of glyphosate sprayed areas and ten (10) plots of adjacent unsprayed fields the layout. Thus, consisting of a total of twenty (20) experimental units used for the investigation. In each of the sprayed and unsprayed plots of similar ecology, three (3) sample points were made, in which a quadrant was repeated thrown into the field three (3) times from the corner of the field. All plant species within the quadrant were enumerated, pressed, properly tagged and taken to the Department of forestry and environmental management Herbarium, Michael Okpara University of Agriculture, Umudike, Nigeria for identification and/or authentication. The vegetation data collected were analyzed using Mueller Dombis and Ellenberg (1974) index of similarity formula as:

$$\text{Index of similarity} = \frac{2C}{A \times B} \times \frac{100}{1}$$

Where;

C. = smallest sum of the two values common in samples A and B; A= sum of all values as % total stands for all types from sample B. The similarity index ranges from 0 (no similarity) to 100 (complete similarity). For values greater than 75, the two samples are generally considered replicates, they equally stated. A physical count of surviving termite hills (*termitereum*) in each of the plots was observed and recorded. Using a soil auger, soil samples were collected at a depth of 15cm from three (3) samples sites in each of the sprayed and unsprayed field plots. At the Pest Management Technology laboratory of Federal College of Agriculture, Ishiagu, soil samples from the three (3) samples points in each plots was pooled together, 5 litres of water poured into it in a 10 litres elastic container and sieved with 200mm mesh sieve. Therefore, the number of earthworms were counted and recorded. The data collected from both termite and earthworm counts were analyzed using students t- test as previously defined by Rogers (1999). Similarly, soil samples were collected from the plots at three (3) locations at a depth of 15cm using a soil auger. The soil samples were then taken to the soil biology laboratory of the National Root Crops Research Institute, Umudike for microbial (fungi) load/count. Serial dilutions were made using 10g of soils from each sample suspended in 90mls of sterile water, followed by inoculation of 1ml from dilutions factor 10^3 (least visible dilution factor) using four plate method as reported by Shree and Avlis (2003). The plates were incubated at 26^{0C} for 3-4 days with daily monitoring and/or observation of mycelia growth. After 4 days, the plates were observed for colony growth and counted using a counting meter (a *Gallenkamp* colony count). The number of colonies on the plates multiplied by the dilution factor gave plate count per milliliter (ml) of the soil sample solution incubated in the plates (Fawole and Qso; 1998).

Results and Discussion

Results of vegetation analysis showed that a total of 530 and 495 plants were enumerated in unsprayed and sprayed plots respectively. A subsequent community index of similarity assessment revealed a low similarity index (12.24) between sprayed and unsprayed field plots. The results showed that the mean number of termite hills (used as an indicator) were greater in unsprayed plots than sprayed ones. It also revealed significant differences ($P<0.05$) between sprayed and unsprayed fields on termite abundance. Table 3 showed the effect of glyphosate on earthworm abundance in the study area. The result revealed that there were significant differences ($P<0.05$) in the mean Standard Error (SE) of the two areas tested, such that the unsprayed plots recorded higher standard error (9.89) compared to 4.50 observed in sprayed plots. In Table 4 is shown (fungi) load of soil in the study area. The results of microbial count revealed that a higher mean fungi load of 31.1 X 10^3 fungi per millitre (ml) of soil sample solution was observed in unsprayed plots while sprayed fields recorded lower mean fungi load of 15.45 per ml of soil sample solution.

Table 1: Effect of glyphosate on vegetation

The following plants species were collected from the sample plots.
(A) From unsprayed areas:

S/N.	Names of plant collect	abundance/population
1.	*Stachylarpheta jamaicansis*	*30*
2.	*Oldenlanddia herbacea*	*20*
3.	*Pennistum pedicellatum*	*15*
4.	*Nauelea latifolia*	*25*
5.	*Schwenckia americana*	*10*
6.	*Argeratum cohyoides*	*05*
7.	*Hyptis lanceolata*	*15*
8.	*Desmodium salicifolium*	*05*
9.	*Phyllanths amarus*	*20*
10.	*Paspalum scorbiculatum*	*05*
11.	*Andropogon tectorum*	*25*
12.	*Panicum laxum*	*10*
13.	*Scoparia dulcis*	*15*
14.	*Melastomastrium capitatum*	*10*
15.	*Cyperus haspan*	*10*
16.	*Laggera aurita*	*15*
17.	*Chromolena odorata*	*05*
18.	*Ficus caria*	*05*
19.	*Harungana madagascariensis*	*10*
20.	*Aspilia africana*	*35*
21.	*Desmodium scorbpiurus*	*25*
22.	*Acroceras zizanoides*	*05*
23.	*Lonchocarpus cyanescens*	*10*
24.	*Xeroderis impressa*	*05*
25.	*Aeschynomene indica*	*10*
26.	*Ipomea involucrate*	*15*
27.	*Diodia sarmentosa*	*05*
28.	*Indigofera hirsute*	*10*
29.	*Imperata cylindrical*	*40*
30.	*Calopogonium mucunoides*	*20*
31.	*Impomea alata*	*20*
32.	*Mimosa pudica*	*10*
33.	*Hyperthelis disoluta*	*15*
34.	*Andropogon gayanus*	*15*
35.	*Impomoea triloba*	*20*
36.	*Cliysopogon aciculatus*	*15*
Total/abundance		**530**

The effect of the glyphosate herbicides on the insect (termite) is shown in Table 2.

(B) From sprayed areas:

S/No.	Names of plants collected	abundance/population
1.	*Stachylarpheta jamaicansis*	25
2.	*Oldenlandia herbacea*	05
3.	*Pennisetum pedicellatum*	05
4.	*Nauelea latifolia*	10
5.	*Schwenckia Americana*	05
6.	*Argeratum cohyoides*	*10*
7.	*Hyptis lanceolata*	*45*
8.	*Desmodium salicifolium*	05
9.	*Phyllanths amarus*	*30*
10.	*Paspalum scorbiculatum*	*35*
11.	*Andropogon tectorum*	*15*
12.	*Panicum laxum*	*05*
13.	*Scoparia dulcis*	*10*
14.	*Melastomastrium capitatum*	*10*
15.	*Cyperus haspan*	*05*
16.	*Laggera aurita*	*25*
17.	*Chromolena odorata*	*10*
18.	*Sacciolepis africana*	*10*
19.	*Euphorbia hetrophylla*	*10*
20.	*Spigelia anthelmia*	*30*
21.	*Sida rhombifolia*	*10*
22.	*Brachiaria deflexia*	*10*
23.	*Ipomoea batata*	*15*
24.	*Digitaria ciliaris*	*10*
25.	*Emilia practermissa*	*15*
26.	*Melochia corchorifolia*	*10*
27.	*Polygonum salicifolum*	*10*
28.	*Lotus*	*10*
29.	*Vernonia cinerea*	*10*
30.	*Panicum maximum*	*10*
31.	*Echinochloa pyramidalis*	*10*
32.	*Echinochloa colona*	*10*
33.	*Eragrostis atrorirens*	*05*
34.	*Mimosa pudica*	*10*
35.	*Lagenana breriflon*	*05*
36.	*Buphia pubescens*	*05*
37.	*Ipomoea aquatica*	*10*
38.	*Sporobolus pyramidalis*	*05*
39.	*Mitracarpus villosus*	*05*
40.	*Clappertonia*	*05*
41.	*Alchornea cordifolia*	*05*
42.	*Mulithia spp*	*05*
Total/abundance		*495*

Effect of glyphosate on earthworm count

Table 3: Mean Population of Earthworm Count.

S/N	Unsprayed	Sprayed
1.	30	10
2.	29	22
3.	11	7
4.	44	43
5.	50	23
6.	40	18
7.	67	33
8.	91	43
9.	105	10
10.	15	18
Total	482	22
Mean	48.1	22.7
SE	9.89	4.54

The impact of glyphosate herbicide on Termite Hill

Table 4: Mean Population of Termite Hill

S/N	Unsprayed	Sprayed
1	3	2
2	6	0
3	5	1
4	8	2
5	2	0
6	3	0
7	3	1
8	2	0
9	1	0
10	2	0
Total	35	6
Mean	3.5	0.6
SE	6.89	2.67

Results of vegetable enumeration and subsequent similarity index analysis revealed great disparity between sprayed and unsprayed plots in species occurrence and population abundance. There were more number of species in sprayed plots (due to nature flare back phenomenon) but depleted in total plant population abundance compared to unsprayed fields. This could be supported by Steve and Randal (2004) who stated that glyphosate application led to increased frequency of some native species but also a decrease in other native species. The decline of plant abundance on sprayed areas could be attributed to long time application of glyphosate herbicide in the study area. These tallies with Schroll *et al,* (1994) who reported that concentrations of herbicides on plant tissue can eliminate plant species or reduce their abundance. Furthermore, Steve and Randal (2004) stated that repeated treatment using glyphosate strongly reduce vegetative cover to near zero at 0.14kg/hectare. On farm continued application of glyphosate containing herbicide can significantly affect the numbers and diversity of plant species around field edges (Zobiole *et al*; 2011). The higher number of earthworm count recorded in unsprayed plots and the depleted number in sprayed areas could be ascribed to prolonged application of glyphosate herbicide in the area. This findings is in line with the result of Relyes (2004) who revealed that wide sprayed mortality of earthworms and other soil micro-organisms were as a result of the herbicide glyphosate. Glyphosate-containing could be toxic to earthworms, while the growth rate of some species are reduced by its application (Casabe *et al;* 2007). The significant decline in the population of termites in herbicide sprayed fields is directly the effect of sustained glyphosate application. However, indirect effect may be due to depleted vegetation rash, which provide regular food for termites. Henry et al (1994) had reported that glyphosate exposure caused a decrease in survival of soil termites and other soil inhabiting organism. It is apparent that the result of reduced microbial load observed on sprayed plots could be attributed to continual glyphosate application and in conformity with Haney et al (2000) who observed that the population of micro-organisms that suppresses disease causing fungi have been found to decrease in soils treated with glyphosate.

Conclusion

Findings revealed that sustained glyphosate treatment negatively impacted on plant species abundance, earthworm count, termite hill and microbial fungal load by reducing their frequency. The conservation of biological diversity is becoming an integral part of sustainable management of forest and agro-ecosystems. The result of this negative effect of prolonged glyphosate herbicide application on our crop and environment has engendered the need for a research into ways of reducing herbicide use and to properly evaluate the level of damage to the ecosystem. We therefore, have to strike a balance between increased crop productivity by the use of herbicides and maintenance (sustenance) of sound environmental quality.

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Response of *Caryedon serratus* (Olivier) to *Moringa oleifera* (Lam) and *Garcina kola* (Heckel) on Stored Groundnut

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Abstract
Plant derived powders of Moringa oleifera Lam (drum stick) and Garcina Kola Heckel (bitter kola) have been found effective as protectants of stored grain against sitophilus zeamais Motch, but limited evidence suggest that they may be useful in the control of the groundnut bruchid Caryedon serratus (Olivier).the present experiment was targeted to test this proposition. Leaf powder of M.oleifera and seed powder of G. kola were used to surface treat groundnut kernels in storage with a view to offering protection against the beetle C. serratus. Results showed that all powder concentrations of the two plants were significantly (p<0.05) more toxic to the insect relative to untreated control. However, powders of G. kola were more potent than the powders of M. oleifera, which were not too efficacious with the highest test concentration (4g) of G. kola recording the highest mean percentage mortality of 81.25% compared to the synthetic check pirimiphos methyl. Seeds treated with the two doses of G. kola powder significantly retarded post-embryonic development by the insect. Similarly, plant powders of G. kola effectively offered protection against weight loss and feeding damage by the beetle, while the powders of M. oleifera were moderately protective. The potential practical application of plant derived powders of G. kola as seed protectants and alternative synthetic pesticide available to the resource-limited farmers in West Africa is discussed.

Introduction
Groundnuts are stored both as unshelled pods and as kernels for different uses. They can be eaten raw, used in recipes, made into solvent and oil, and used in making-up medicines, textile materials, peanut butter and many other products. Both forms are vulnerable to attack by a plethora of insect pests after harvest. However, groundnut kernels are more susceptible to insect pest attack than pods in storage (Dudley and Rodney, 2003). All stored products are attacked by a wide range of insects and the most predominant among the insects are the beetles and moths. More than 100 insect pest species are known to live and feed on stored groundnuts (Cunningham and Walsh, 2002), some of which are of economic importance. The *bruchid* beetle *Caryedon serratus* (Olivier) is a major insect pest causing severe damage to oil seeds, especially groundnut. According to Duley and Rodney, (2003) reports of groundnut kernel damage by *C. setrratus* from different parts of the world have been well documented, leading to post-harvest losses of about 10-25% of the population. Insect infestation in groundnut is well known for causing direct loss, but indirect loss in terms of quality of the produce also impacts on its trade and uses. Therefore, arose the need to control the pest in storage since it reduces the economic value and viability of the crop. The use of synthetic chemicals seem to be the most effective, but most hazardous. Control of this insect pest often relies heavily on the use of synthetic insecticide, but increasing cost of application and erratic supply in developing countries due to foreign exchange constrains have stimulated interest in the development of alternative control strategies. The problems of many synthetic insecticides include high persistence, poor knowledge of application, increasing costs of application, pest resurgence, and genetic resistance by the insect and lethal effects on non-target organism in addition to direct toxicity to users (Okonkwo and Okoye, 1996). With a view to arresting/militating the apparent pollution problems in the environment and avoiding toxic effects of synthetic chemicals on non-target organism, studies on exploiting pesticides of plant origin are becoming increasingly popular in

the field of stored products entomology. Much of the plant kingdom remains unexplored for possible exploitation against insect pests. Currently, attention is being given to the use of edible plant materials as grain protectants (Ivbijaro and Agbaje, 1986; Mbah *et al*, 2011), and the tropics is well endowed with these plant species some of which are also used for medicinal purposes. Protection of stored products generally involves mixing grains with protectants made up of plant materials. The use of these traditional materials has recently induced active research to establish the scientific basis for their continued use regarding their efficacy, active constituents and effective application technology (Poswal and Akpa, 1999; Bekele, 1994). The focus of the present investigation was conceived to increase the data bank of natural products used in control of stored product insects and to test the potency of powders of drumstick (*Moringa oleifera* Lam) and bitter kola (*Garcina kola* Heckel) and their phytochemicals against the groundnut *bruchid C. serratus*.

Materials and Methods

Insect Culture

The groundnut *bruchid (C. serratus Olivier*) was reared for eight (8) weeks in the laboratory maintained at $28^{0c} {}^{+}{}_{-} 3^{0c}$, 65-70% relative humidity and 12h light dark regime. The food medium used was whole groundnut kernel. Fifty pairs of the insect species sexed following the report of Sembene *et al,* (2010) were placed in a 2-litre kilner jar containing 500g kernels of peanut. The jar was covered with a nylon mesh held with a rubber band. The groundnut grains for the investigation were disinfested by deep-freezing at -2^{0c} for 2 weeks. The seeds were thereafter, air-dried in the laboratory for 24hours prior to use. The air-dried plant materials used for the study were collected from Nigeria. They were the leaves of *M. oleifera* (drum stick) and seeds of *G. kola* (bitter kola). These plant materials were thoroughly washed with sterile water, and later dried in a well-ventilated laboratory room for 8-10 days depending on weather conditions. They were pulverized into very fine powder using an electric blender, passed through a 2-mm mesh micro sieve. The powders were later sealed in cellophane bags and stored in a refrigerator at 5 0c before used to prevent loss of active principle (Sherman, 1982).

Insect Bioassay

The plant powders of *M. oleifera* and G. kola both at the dosage levels of 2g and 4g and 0.04g of a synthetic check *pirimiphos methyl* were each weighed into 50g of clean undamaged and uninfected groundnut seeds (kernel) in kilner jars. The kernels in the control jars contained no chemical treatment or powders. The contents of the jars were gently shaken to ensure thorough admixture of the groundnut kernels with the insecticidal treatment powders. Twenty (20) (ten pairs) of 2-3 days old adult beetles *C. serratus* were inoculated into each of the jars covered with muslin white cloth held with a rubber band. Four replicates of both the treated and untreated control jars were laid out in a laboratory bench in completely Randomized design (CRD). At 1 and 7 days after inoculation, adult mortality/longevity was assessed by counting the dead and living insects carefully. Adults were considered dead when probed with sharp objects and there were no responses. On day 8, all insects, dead and alive were removed from each jar and the kernels returned to their respective jars. F1 progeny development was subsequently assessed at 8 weeks (56 days). The contents of the kilner jars were sieved out and newly emerged adult beetles were counted as F1 progeny. After 9 weeks, the groundnut grains were re-weighed using a melter balanced and percentage weight loss was evaluated as:

$$\%\text{ weight loss} = \frac{\text{initial weight-final weight}}{\text{Initial weight}} \times \frac{100}{1}$$

After 3 months of storage, damage assessment was carried out on treated and untreated seeds. Random samples of 100 seeds were taken from each jar and the number of damaged (seeds with characteristic emergent holes) and undamaged (wholesome) kernels were counted. Thereafter, percentage seed damage was determined following the methods:

$$\%\text{ seed damage} = \frac{\text{Number of seeds perforated}}{\text{Total number of seeds sampled counted}} \times \frac{100}{1}$$

Phytochemical composition of the plant materials used for the study was assessed according to the method of Oberlease (1973). Data collected were analyzed using the analysis of variance

(ANOVA). Differences in treatment means were separated using the least significant difference (LSD) test at 5 % probability according to Steele and Torrie (1980).

Results and Discussion

The toxic effect of the plant derived powders of *M. oleifera* and *G. kola* to *C. serratus* on groundnut kernels in storage is presented in Table 1. The result revealed that the synthetic insecticide *pirimiphos* methyl (which was used as a check) significant offered the most effective control of the insect and achieved 100% mortality. All the candidate plant powders significantly ($p<0.05$) reduced the longevity of the beetle on treated seeds with *bruchid* mortality ranging from 32.50% to 81.25%. Among the plant derived powders, the highest concentration of G. kola (4g) was the most potent against *C. serratus* with mean percentage mortality of 81.25% after 7 days of exposure, followed by *G. kola* at 2g dosage level (62.50%). *M. oleifera* treatments were not as efficacious with the lower dose of 2g evoking the least mean percentage mortality of 32.50% 7 days after treatment storage, which was better than the untreated control. Table 2 show the F1 progeny produced by groundnut seeds treated with different levels of plant derived powders. The different plant powders significantly ($p<0.05$) reduced the progeny of *C. serratus*. The G. kola treatments were found most effective in regarding progeny emergence of *C. serratus* on stored groundnut kernels compared to *M. oleifera* powder. The synthetic insecticide (*pirimiphos* methyl) completely suppressed post-embryonic development of the *bruchid.* The highest mean number of adults (14.50) equivalent to 72.50% emerged from the control seeds.

Groundnut kernel treated with plant powders of *M. oleifera* and G. kola showed significant differences (<0.05) in the reduction of weight caused by *C. serratus* (Table 3). The highest mean percentage weight loss of 46.00% was observed on groundnut seeds treated with the lower concentration (2g) of *M. oleifera,* which was followed by the highest level of 4g with 40% loss. However, the two dosage rates of G. kola 2 and 4g were significantly more effective in inhibiting weight reduction than the control with 70% weight loss. Seeds treated with the two concentrations (4g and 2g) of G. kola powder were significantly ($p<0.05$) the least damaged with mean percentage damage of 5.25% and 7.00% respectively (Table 4). The result indicates that these treatment powders were the most effective in protecting groundnut seeds against damage by the beetle. The most damaged kernels were found in jars treated with the two levels of *M. oleifera* 4 and 2g, which were statistically the same but significantly different ($p<0.05$) from the other treatments. Over all, the level of damage (59%) was highest in untreated control jars. The results of the phytochemical analysis of the plant powders shown in Table 5 revealed that the two plant materials contained typical plant constituents such as phenols, tannins, alkaloids, flavonoids saponins and oxalates at varying degrees.

Table 1: Effect of plant powders on adult mortality of *C. serratus* 1 and 7 days after treatment

Treatment	conc. G/50g Seeds	Mean no of dead insects in days 1	and 7	Mean (%) mortality in days 1	and 7
M. oleifera	2	0.00	6.50	0.00	32.50
M. oleifera	4	0.25	7.50	1.25	37.50
G. kola	2	2.25	12.50	11.25	62.50
G. kola	4	3.25	16.26	16.25	81.25
Pirimiphos methyl	0.04	20.00	20.00	100.00	100.00
Control	0.00	0.00	0.00	0.00	
LSD (P<0.05)	3.56				

Table 2: Effective of powders of *M. oleifera* and *G. kola* on emergence of *C. serratus*

Treatment G/50g	onc. inoculated	No of insects generation	mean F1 generation	% FI
Seed				
M. oleifera	2	20	10.00	50.00
M. oleifera	4	20	9.50	47.50
G. kola	2	20	5.0	25.00
G. kola	4	20	3.00	15.00
Pirimiphos methyl	0.04	20	0.00	0.00
Control		20	14.50	72.50
LSD (P<0.05)		20	3.77	

Table 3: Effect of insecticidal treatments of two plants on groundnut kernel weight loss three months after storage

Treatment	conc. g/50g Seed	Initial weight of seeds	Final weight of seeds	Mean weight loss of seeds	mean % weight loss
M. oleifera	2	200.00	108.00	92.00	46
M. oleifera	4	200.00	120.00	80.00	40
G. kola	2	200.00	154.00	45.20	22.60
G. kola	4	200.00	162.00	38.00	19.00
Pirimiphos methyl	0.04g	200.00	200.00	0.00	0.00
Control		200.00	60.00	140.00	70.00
LSD (P<0.05)		4.49			

Table 4: Effect of plant powders on kernel damage after three months treatment storage

Treatment seed Seed	conc. G/50g	No of grains sampled	Mean no of seeds with adult emergent holes	% damage
M. oleifera	2	100	17.25	17.25
M. oleifera	4	100	14.00	14.00
G. kola	2	100	7.00	7.00
G. kola	4	100	5.25	5.25
Pirimiphos methyl	0.04	100	0.00	0.00
Control		100	59.00	59.00
LSD (P<0.05)	4.49			

Table 5: phytochemical composition (%) of the plant materials assayed

Plant materials	Phenols	Tannins	Alkaloids	Phytochemicals	Saponins	Oxalates	Favonoids
M. oleifera	0.15	0.88	0.40	0.86	2.48	1.06	
G. kola	0.70	1.20	4.52	1.31	1.45	0.75	

The potency of *G. kola* was high against *C. serratus* while *M. oleifera* powders was not that potent.

Results show that the mortality of the insect caused by the plant derived powders was Concentration dependent, and similarly related to the time of exposure. The resultant high mortalities of adult *C. serratus* observed on groundnut kernels treated with *G. kola* powder could be due to high toxic effect of the product on the groundnut *bruchid*. This result corroborates the findings of IIeke and Oni (2011) who reported that *G. kola* powder caused 89.70% weevil mortality after 72 hours of exposure and reduced adult emergence of *S. zeamais* Mbailao *et al; (2006) reported the effect of M. oleifera* oil on longevity of *callosobruchus maculatus* on cowpea grains. The efficacy of *G. kola* could be due to the crude toxic oil content. The phytochemical study showed that the more toxic plant powder of G. kola had a high content of the bioactive phytochemicals like alkaloids, phenols, tannins and comparatively lower proportion of oxalates and saponins. The bioactivity of different *Ocimum kenyense* plant materials against the insects may depend on several factors including chemical composition, species susceptibility and ariation in insect behavior (Cassida, 1990). Mbah (2010) had stated that the active constituents in the plant materials appear to be responsible for their inhibition effect against *Oryzaephilus mercator* onstored *Irvingia* and suggested that the high alkaloid content of *Jatropha curcas* might have contributed to the high toxic effects of the plant. Thus, these alkaloids might likely be the undesirable poisonous chemical element in the seeds, which render the oil toxic and not appropriate for human consumption (Lele, 2008). The high percentage mortality and low adult emergence at higher concentration caused by the powder of *G. kola*
can be attributed to the bitter compound in the seed (Trease and Evans, 1989). The present result seem to have validated the previous report of Okwu *et al,* (2007) who stated that the inhibition property of the extracts reside mainly in the phytochemicals contained in the plants. The plant powders also caused significant reduction in feeding damage, weight loss and the numbers of F1 progeny produced by the insect, which indicate the higher protectant potential of those powders against insect damage. The significantly lowered level of F1 emergence, kernel weight loss and damage of groundnut seeds stored with these plant powders points to the fact that the development of *C. serratus* was greatly inhibited by these powders. Mbailao et al, (2006) reported the effect of G. kola powder on reduced progeny emergence
of *Sitophilus zeamais* at the dosage rate of 12.5 and 25.0g *w/w. M.oleifera* at high concentration also reduced adult emergence of *S.zeamais. Ivbijaro* (1990) revealed that pure *neem* and the mixtures of *neem-Moringa* seed oil at 1.5ml/200g was more potent in protecting *stored* cowpea

grains against infestation and damage by *C. maculatus.* The result of this study indicate good potential for the use of *G. kola* as protectant and toxicant agents in storage pest management systems. They also demonstrate a possible scientific rationale for the incorporation of seeds of *Garcina* species into grain protection practices in Nigeria and indeed throughout the region. Botanical toxicants are broad-spectrum pesticides, and many are safe to apply, eco-friendly and can be produced by farmers and small-scale industries and therefore potentially less expensive. The chemical identity of the components from the plant powders is therefore of

Special interest. We believe that the identification of the active principles' and their mode of action currently in practice is expected to generate interest for their use in store products entomology. The use of plant materials in pest control could become important supplement to imported synthetic pesticides.

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Number of Tubers and Tuber Size indices for Selection of Hybrid White Yam Genotypes for Multilocational Trial

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Abstract
Eleven hybrid white yam genotypes plus three landraces of white yam were tested in the Western experimental field of N R C R I, Umudike in 2016 and 2017 with the objectives to identify and nominate superior high yielding candidate varieties in terms of number of tubers and tuber size with desirable tuber characteristics for release to farmers across the agro ecological zones for possible commercial yam production. The experiment was laid out in a randomized complete block design with three replications in an area of land that was mechanically ploughed, harrowed, ridged and spaced at 1m apart. Yam setts weighing 40g were sown 45 cm apart on the crest of the ridges and 10 cm below the soil surface and 100cm between ridges in a plot size of 20m². Data were collected on: mean total number of tubers tuber yield, number of ware tuber yield, number of seed tuber yam, number of mini-tubers and number of micro-tubers. Data on tuber yield related components such as tuber size and tuber shape were collected. Result indicated that Five hybrid yam genotypes 99/Amo/003 (37.5/1000plants/ha), 99/Amo/109 (54.4/1000plants/ha), 99/Amo/95A (41.8/1000plants/ha), 99/Amo/17 (36.6/1000plants/ha), and 99/Amo/060(43.6/1000plants/ha) are hereby recommended for its high number of tuber yield. They yielded more than Adaka (second Check variety) but lower than Ame (first Check variety) in their mean total number of tuber yield in number per plant per hectare. They have high bulking rate an indication of accumulation of usable fresh carbohydrate and cylindrical shape (TSI = >1 and <4) that is acceptable to consumers and command high market value. These genotypes are therefore nominated for multi-locational agro-ecological trial and release to farmers.
Keywords: Yam genotypes, number of tubers, high yield, agroeccologies and nomination

Introduction
In Nigeria, yam is cultivated by subsistence farmers in densely populated high potential zones. In these areas, yields realized from the farmer's fields are very low between 3.5 to 5.0t/ha (Ezulike et al., 2006). This has been as a result of low yield from adapted varieties and poor agronomic practices. To increase productivity in such zones, there is need for the utilization of higher yielding varieties that are widely adaptable across all the agro-ecological zones of the country and by use of application of appropriate agronomic practices (Daisy 2000). In most of yam growing zones, the yield of yam crop is measured not by weight of fresh tubers but by counting the number of harvested tubers per plant and per plot. The objective of this sturdy was to identify and nominate superior high yielding number of tuber candidate varieties with desirable tuber sizes attributes for tuber marketability and for release to farmers across the agro ecological zones for possible commercial yam production.

Materials and Method
Eleven hybrid white yam genotypes plus three landraces of white yam were tested in the Western experimental field of N R C R I, Umudike in 2016 and 2017. The experiment was laid out in a randomized complete block design with three replications in an area of land that was mechanically ploughed, harrowed and ridged at 1m apart. Yam setts weighing 40g were sown 45 cm apart on the crest of the ridges and 10 cm below the soil surface and 100cm between ridges in a plot size of 20m². The plots were kept weed-free manually. There was no Fertilizer application. Pre-emergence herbicide (Diuron) was used immediately after planting and complemented with

manual weeding at 12 weeks after planting (WAP). Data on yield related components were collected such as: number of total tubers produced per plant per hectare, number of ware tubers (>1000g) per plant per hectare and number of seed tubers (>500g<1000g) produced per plant per hectare, number of mini-tubers (>25g<500g) and number of micro-tubers (<25g). Data on other tuber yield related components such as tuber size and tuber shape were collected. Numbers of tuber yields were analyzed using Analysis of variance and means separation was done using standard error of difference means. Tuber Shape was scored after determining the tuber shape index (Orkwor *et al*., 2000). TSI = _ L/W. InTuber Shape Index Less than 1.0 = fair shape, 1.0 = very good shape, 2.0 = good shape, 3.0 = moderately good shape, 4.0 = poor shape, 5.0 = very poor shape. (IBPGR, 1997).

Results and Discussion

Number of tubers: The number of tubers contributes to the yield of the yam crop and is a function of yield. The result of mean total number of tubers, number of ware tubers, number of seed tuber yams, number of mini-tubers, and number of micro-tubers are presented in Table 1.

Table 1: Mean number of Tuber yield characteristics of the hybrid white yam genotypes as characteristics for marketability and agronomic traits for two years combined

Clone name	Mean Total number of tubers	Mean Number of ware tubers (1kg and above)	Mean Number of seed yams (>500<1000g)	Mean Number of mini-tubers (>25<500g)	Mean Number of micro-tubers (1g <200g)	% number of micro-tubers
99/Amo/064	28.2	12.0	13.2	3.0	0.0	0.0
99/Amo/109	54.4	19.2	25.1	5.1	5.0	9.25
99/Amo/060	43.6	12.1	25.2	3.3	3.0	6.98
99/Amo/080	26.5	3.2	19.1	3.2	1.0	3.85
99/Amo/114	25.4	10.3	15.1	0.0	0.0	0.0
99/Amo/040	18.0	10.0	5.0	18.0	0.0	0.0
99/Amo/17	36.6	0.0	0.0	0.0	36.6	100.00
99/Amo/056	28.3	4.0	2.2	21.1	1.0	3.57
99/Amo/95A	41.8	2.4	12.2	22.0	5.2	12.20
99/Amo/003	37.5	6.3	7.2	21.0	3.0	8.11
99/Amo/X5	30.6	5.3	8.2	11.0	6.1	20.0
Ame	47.9	5.4	15.3	20.0	7.2	14.89
Nwopoko	36.7	9.0	21.5	4.2	2.0	5.56
Adaka	31.5	2.3	18.2	9.0	2.0	6.45
Mean	**34.79**	**7.25**	**13.39**	**9.29**	**5.15**	
Std error	19.92	0.82	19.11	8.66	5.14	
Sig. level	P<0.01	P<0.01	P<0.05	P<0.05	P<0.05	

There was high significant (P<0.01) variation in the total number of tubers, number of ware tubers, number of mini-tubers and number of micro-tubers evaluated in the two years combined (Table 1). The mean of total number of tubers varies from 18.0 to as high as 54.4 tubers (99/Amo/ 109) produced by the genotypes. However, the genotype 99/Amo/064 with 54.4 number of tubers produced more number of tubers than three of the check varieties (Ame with 47.9 tubers followed by Nwopoko with 36.7 tubers and Adaka with 31.50). The number of tubers across the genotypes for the two years combined indicated that there was high mean number of seed tubers (13.39 tubers) produced than number of ware tubers (7.25), number of mini-tubers (9.29) and number of micro-tubers (5.15). High number of seed tubers and mini-tubers are indication that the hybrid white yam genotypes could be used in the production of seed tubers for commercial ware tuber yam production and for seed tuber for marketability, and could be produced using the 40g seed weight. However, high percentage of micro-tubers produced by the genotype 99/Amo/17 and no ware yam tubers was an indication of early warning for genetic erosion. Such genotypes if not rescued, will be genetically eroded. Factors that could contribute to high percentage of micro-tuber poduction by yam genotypes include: multiple vines, continuous depletion of soil nutrient without replenishment, non adaptability of the genotypes to the local environment and as such the genotype could be endangered. However, to save the genotype was to embark on genetic rescue to save it from the environment. The genotypes 99/Amo/17 had 100.0% Micro-tubers and if not rescued will be genetically eroded. It is equally an indication that the yam genotype is not well adapted to the local environmental conditions and as a result could be endangered. Endangered genotypes should be planted only in an environment where they perform well. However, number of tubers is a function of yield. It is one of the yield factors. It is the first visual factors on which a farmer uses to assess the yield performance of his crop. Numbers of tubers per plant and per plot indicate the yield performance of a crop. That is what the farmers use to assess a high yielding crop. Most farmers (especially rural farmers) do not use fresh weight yield of a crop to assess the yield performance of crops. The number of tubers per plant gives the eye assessment of the yam crop yield and could be calculated per hectare by multiplying the number of tubers per yam plant per every 1000 yam plants per hectare. Yam genotypes with high number of ware yam tubers or seed tuber yams depending on the objectives could be selected as high yielding variety. The following genotypes should be selected for marketable seed yam production: 99/Amo/109, (25.1) and 99/Amo/060 (25.2). The three hybrid white yam genotypes produced more number of seed tuber yams than the check varieties - Nwopoko with 21.5t/ha, Adaka with, 18.2% and Ame with 15.3t/ha (Table 1).

Tuber size: The results of the size of the yam tuber in length, tuber width and tuber shape index are presented in Table 2.

Table 2: Mean tuber length, tuber width and tuber shape index

Clone name	Mean Maximum tuber length (cm)	Mean Maximum tuber width (cm)	Tuber shape index
99/Amo/064	28.50	7.45	3.80
99/Amo/109	29.00	7.98	3.63
99/Amo/060	28.10	8.20	3.43
99/Amo/080	31.53	10.0	3.16
99/Amo/114	28.91	8.21	3.52
99/Amo/040	27.60	7.33	3.87
99/Amo/17	30.00	7.55	3.97
99/Amo/056	34.30	9.19	3.73
99/Amo/95A	22.93	7.98	2.90
99/Amo/003	28.20	7.87	3.60
99/Amo/X5	26.13	6.83	3.80
Ame	29.38	8.31	3.50
Nwopoko	29.34	7.6	3.86
Adaka	29.38	8.31	3.50
Std error	5.6	2.9	3.54
Range	22.93-30.0	6.83-10.0	3.16-3.97
Mean	28.81	8.06	3.84
Sig. level	P<0.05	P<0.05	P>0.05

Tuber Shape Index = Less than 1.0 = fair shape, 1.0 = very good shape, 2.0 = good shape, 3.0 = moderately good shape, 4.0 = poor shape, 5.0 = very poor shape. Tuber surface Texture

The results indicated the mean tuber size of the 14 yam genotypes in terms of bulkiness. There was significant (P<0.05) variation in the length and width of the hybrid yam genotypes. The significant (P<0.05) genotypic mean tuber size variation among the hybrid white yam genotypes which ranges from 22.93cm to 30.0cm in length and 3.16 to 8.97cm in width which indicated the extent of fresh carbohydrate accumulation and the rate of photosynthetic efficiency among the genotypes. The length and width of the tubers measures the tuber size which is the dimension, extent or how large the yam tubers were. The yam genotype with the longest tuber length was 99/Amo/056 with 34.30cm and tuber thickness of 9.19cm more than the two landraces (Table 2) which indicated high fresh carbohydrate accumulation and more photosynthetic efficiency more than the three landraces. Other genotypes with long tubers and larger width more than the landraces were 99/Amo/080 with length 31.53cm and width 10.0cm. This indicated high bulking rate of the hybrid yam genotypes. Consumers who need yam tubers for consumption buy ware yam tubers that are large. However, the farmers uses the size of yam tubers to assess the yield performance of the yam crop especially since yam plants are generally known to produce one tuber per plant. Yam genotypes that produces large tubers (ware tubers) when compare with the planted seed weight is regarded as high or low yielding genotypes. For example in commercial ware tuber (1000 and above kg) production, seed sizes weighing 150 to 250g are used. However, yam genotypes that produces ware tubers from seed tuber size weighing 40g could be regarded as high yielding genotypes if the tuber produced weighed 1000g and above. Nevertheless, there are some factors that can affect the size of yam tubers to be small. These factors includes: low fertility of the soil, nutrient in balance such as high nitrogen fertilizer, none staking of the yam plot, unweeded plots, pests and diseases infestation and general neglect of the yam field (Onwueme, and Sinha, 1991).

Tuber shape: The hybrid yam genotypes and the landraces have straight sides with almost circular ends of equal size and a constant circular cross section that can go for as cylindrical shape. This type of shape is not prone to damage during yam harvest and easy for tying on stakes during storage. Branched yam tubers are liable for damage during harvesting. All the yam genotypes including the landraces have cylindrical shapes. Hence the tuber shape index is within region of general acceptance (TSI = >1 and < 4). The mean tuber shape of all the hybrid clones was 3.84 which is an indication of cylindrical shape. This shape lends itself for ease of peeling during processing for food than round or flat shape. Yam tubers with cylindrical shape command high market prices. However, yam tubers with cylindrical shape grow deeper into the soil and less prone to breakage during harvesting. Tuber shape has indirect effect on the tuber size. When a tuber is large, the shape will manifest, it will be clearly seen if it is a round tuber, cylindrical or flat. Yam tubers with cylindrical shape are easy to harvest and command high market price. .

Conclusion

Five hybrid yam genotypes 99/Amo/003 (37.5/1000plants/ha), 99/Amo/109 (54.4/1000plants/ha), 99/Amo/95A (41.8/1000plants/ha), 99/Amo/17 (36.6/1000plants/ha), and 99/Amo/060 (43.6/1000plants/ha) are hereby recommended for its high number of tuber yield. They yielded more than Adaka (second Check variety) but lower than Ame (first Check variety) in their mean total number of tuber yield in number per yam plant per hectare. They have high bulking rate (size) an indication of accumulation of usable fresh carbohydrate and cylindrical shape (TSI = >1 and <4) that is acceptable to consumers and command high market value. These genotypes are therefore nominated for multi-location agro-ecological trial and release to farmers.

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Preliminary Verification of the Adoption of some *Dioscorea alata* Released Varieties using Simple Sequence Repeats

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Abstract
Nigeria is considered to be the largest producer of Dioscorea spp, a crop that provides an affordable source of carbohydrates to more than 80% of the country. Due to the ease of propagation and better agronomic flexibility Dioscorea alata or water yam is one of the most widely cultivated by small holder farmers. The aim of this study was to determine the genetic relatedness between three improved accessions and samples collected from farmers in certain yam cultivating regions; using simple sequence repeats (microsatellite). The loci used in this study showed, on average, 69.81% polymorphism and were discriminatory enough for this specie. This preliminary study, showed relatedness between released TDa 98/01168 and TDa 98/01176 and two accessions sampled from two different farmers' fields in Benue state while TDa 98/01168 was closely linked to four different farmers in Oyo, Kogi and Benue as well. This study provides baseline information for further adoption studies of released D. alata varieties.

Introduction
Yam (*Dioscorea* spp) is considered a major source of food and income (Sartie and Asiedu, 2011). One of the major cultivated specie, is the edible *Dioscorea alata* (also known as 'water yam', 'winged yam' and 'greater yam'). On a commercial scale, it is second only to the guinea yam complex (*Dioscorea cayenensis-rotundata*); and its commercial success is as a result of several factors, including high nutritional qualities, low glycemic index, easy of management, high yield and resistance to yam mosaic virus (Siqueira et. al., 2012, Siqueira et al., 2014, Egesi et al., 2002). Over the years, several breeding programs have sought to produce improved yam varieties acceptable to farmers and consumers alike. The yam breeding programs, managed by the National Root Crop Research Institute and the International Institute for Tropical Agriculture have developed and released *D.alata* varieties with improved traits.. In 2016, a preliminary survey was conducted to determine the adoption status of three improved *D.alata* varieties (Table 1), released to farmers in Nigeria It is well documented that farmers change the varietal names of theses released varieties to suit their local preferred names for yam. This introduces a level of confusion as to the true status of officially released varieties in farmers' fields. We describe in this paper, the use of simple sequence repeats (SSR) or microsatellites to identify those three released varieties from some pilot sites.

Table 1: IITA released *D. alata* varieties, used in this study, with year of release and improved qualities. Leaf samples were collected from IITA multiplication trials

Released varieties	Outstanding characteristics	Year of release
TDa 98/01168	High yielding, pests and diseases tolerant, good for pounded yam, frying and boiling. (24-28t/ha)	2008
TDa 00/00194	High yielding, pests and diseases tolerant, very good for yam, fufu, frying and boiling. (37.5t/ha)	2009
TDa 98/01176	High yielding, pests and diseases tolerant, very good for pounded yam, frying and boiling, suitable for both rainy and dry seasons yam production (26-30t/ha)	2008

Materials and Methods

Sample site and Plant materials

The 4 pilot states used for this study, were chosen based on the active role of the National Coordinated Research Program trials and on-farm verification trials prior to the official release of these *D. alata* varieties. The states targeted included; Oyo, Nassarawa, Kogi and Benue states and farmers' fields were randomly selected. Different *D. alata* varieties cultivated amongst these farmers were sampled. A total of Fourteen *D. alata* were sampled from the randomly selected fields (Table 2). Three officially released *D. alata* varieties as shown in Table 1 was sampled from the breeding field of National Root Crops Research Institute Umudike, Nigeria. All samples were stored at room temperature in silica gels and dried.

Table 2: List of sampled genotypes and sampling site with their physical coordinates

Local names	State sampled	Co-ordinate
Agric-2	Oyo	08°47'38.5N" 003°48'47.3E"
Agric-3	Oyo	08°49'46.4N" 003°46'59.4E"
Ehura	Oyo	08°47'23.5N" 003°48'43.4E"
Oharan	Oyo	08°49'46.4N" 003°46'59.4E"
Agric	Oyo	09°05'52.3N" 003°49'38.3E"
Boko	Oyo	08°47'38.5N" 003°48'47.3E"
Agric-1	Oyo	08°47'58.5N" 003°48'47.3E"
Local -1	Kogi	07°27'20.1N" 007°37'17.8E"
Local -2	Kogi	07°27'20.1N" 007°37'17.8E"
Shakata	Nassarawa	08°22'55.1N" 008°36'45.0E"
Tokula -1	Benue	07°42'59.1N" 008°41'02.9E"
Tokula -2	Benue	07°42'59.1N" 008°41'02.9E"
Tokula-3	Benue	07°42'59.1N" 008°41'02.9E"
Local -3	Benue	07°42'51.0N" 008°41'06.2E"

DNA extraction

Silica gel dried leaf samples were transported to the Bioscience Laboratory, International Institute for Tropical Agriculture (IITA), Ibadan Nigeria. DNA was isolated from the dried leaf (100mg) yam samples using a modified CTAB extraction method as described by Sharma *et al* 2008. The DNA extracts were eluted in 100µl sterile TE buffer and the quality and concentration were assessed by gel electrophoresis using 1% agarose with known concentrations of undigested lambda DNA (Sigma, St Louis, MO, USA) The extracts were further quantified using a Nanodrop spectrophotometer and stored at -20°C for genotyping. Prior to PCR analysis the samples were standardized to 25ng/µl.

PCR Genotyping

Twenty-three SSR primer pairs developed from various yam species were selected to analyse the samples (Tamiru et al., 2015, Tostain et al., 2006). The primer pairs were tested on the released varieties and seven (Table 3) were chosen based on the capacity to reveal polymorphism. PCR reactions were conducted on a thermocycler (Applied Biosytems Veriti 96 well plates) in 10µl volumes containing 1µl of template DNA, 100 µM each of dNTP, 2.5 mM MgCl2, 0.5 µM, 10X reaction buffer and 2 units of Taq DNA polymerase. Depending on the loci used, different touch down PCR cycle program was used as seen in table 1. The PCR amplicons were electrophoresed on 2% agarose gel in 0.5 TBE buffer along with a DNA molecular size marker. Gels were photographed using a gel documentation system.

Gel Scoring and fragment analysis

2µL of PCR amplicons were mixed with loading dye and subjected to further elecrophoresis in 6% polyacrylamide gels at 100V for 30mins. The resolved and unambiguous DNA bands generated from the separation of the PCR products were counted by starting from the top to the bottom of the lanes and were also scored as presence (1) and absence (0) of bands. The binary data generated was analysed using the Gstudio package (Rodney, 2016) of the R software to determine number of alleles, observed heterozygosity, genetic distance and to conduct a clustal analysis.

Results and Discussion

DNA quality and molecular concentration

All 17 samples produced high molecular weight DNA with very good quality. The average concentration of DNA extracted was 2707.4ng/µl, ranging from 1277.8ng/µl to 4317.3ng/µl. The average A260/280 (representing the purity of the DNA extract) for the obtained DNA was 1.88 ranging from 1.78 to 1.95.

SSR pattern of polymorphism

To provide evidence that some of the officially released *D. alata* varieties are being utilized by farmers, SSRs were used in this study to determine the genetic diversity between the released maintained in NRCRI yam breeding program and fourteen sampled genotypes from , from farmers' fields. The high variability and multi allelic nature of SSRs make them low cost informative markers for determining genetic relationships in polyploid plants like *Dioscorea alata* (Girma et al., 2015, Obidiegwu et al., 2009a&b). A total 37 alleles were detected when all 17 accessions were analysed with the 7 highly polymorphic SSR loci. An average of 5.29 alleles were observed per locus (Table 3). The observed heterozygosity of 0.63 on average, varied from 0.47 (Dab2D06) to 0.82 (SSR34). All seven primer pairs produced amplicons with varying levels of polymorphism revealing, on average 69.81% polymorphism. The polymorphic information content ranged from 0.42 (Dab20C5) to 0.69 (Dab2E07) with an average of 0.66.

Table 3: Characteristics of 7 SSR markers used in this study

Primers	5' to 3' Primer sequence	*A*	Ho	Ae	PIC
Dab20C5	CCCATGCTTGTAGTTGT -F TGCTCACCTCTTTACTTG -R	3	0.53	1.74	0.42
D 83	TCGGAATTCAACTGTGATGGC -F AGCACACCATTCACACATAGG -R	6	0.59	2.56	0.61
D 100	GTGTGTGGATGGAGTTTCAAT -F GAATACCCCCAACAGATGTAAT -R	5	0.77	2.32	0.57
Dab2E07	TTGAACCTTGACTTTGGT -F GAGTTCCTGTCCTTGGT -R	6	0.65	3.18	0.69
Ym 34	GGTAATAGAGGGCAAAGTGGC -F AGACCTCCTACCATGCTCAAG -R	5	0.82	2.44	0.59
Ym 51	GAATACATATGGTGCATTCGAG -F GCTGCTTACAACTGACAAAGTC -R	7	0.57	2.98	0.66
Dab2D06	TGTAAGATGCCCACATT -F TCTCAGGCTTCAGGG – R	5	0.47	2.92	0.66

Number of alleles per locus (A), observed heterozygosity (Ho), effective alleles (Ae) and polymorphic information content (PIC)

Genetic distance

Similarity matrix was generated with the Nei similarity coefficient method. An unweighted pair group method and arithmetic mean similarity coefficient method was used to generate a dendrogram (Figure 1). The average Nei's coefficient was 0.59, representing a high genetic diversity also seen in previous studies on *Dioscorea* spp in Nigeria (Obidegwu et al., 2009). The dendogram generated in this study from the cluster analysis classified the 17 accessions into 4 clusters. Two of the released materials sampled from the NRCRI germplasm (TDa 00/00194 and TDa 98/01176) were closely related as shown in cluster 3. This implies they might have similar pedigree history in the breeding program. Two accessions, local-3 and Tokula-2, sampled in Benue from two different farmers also seem closely related to both released varieties as seen in cluster 3. Released variety TDa98/01168 as shown in cluster 4 was closely linked to accessions sampled from Oyo (Agric-2 and Agric -1), Benue (Tokula-1) and Kogi (Local-2). This represents the closest link to possible released materials grown in farmers' fields. Samples that did form clusters and interrelatedness may be clones with close genetic identity.

Conclusion

This preliminary study shows that these markers were highly polymorphic and informative; demonstrating the role SSRs can play in yam breeding programs to determine adoption of released varieties by farmers. The findings indicate that out of the 14 fields sampled, the three released varieties were closely linked to 6 farmers in 3 out of the 4 states. The results from this preliminary study provide the needed baseline to support further investigation on the subject of yam variety adoption status in yam cultivating regions in Nigeria.

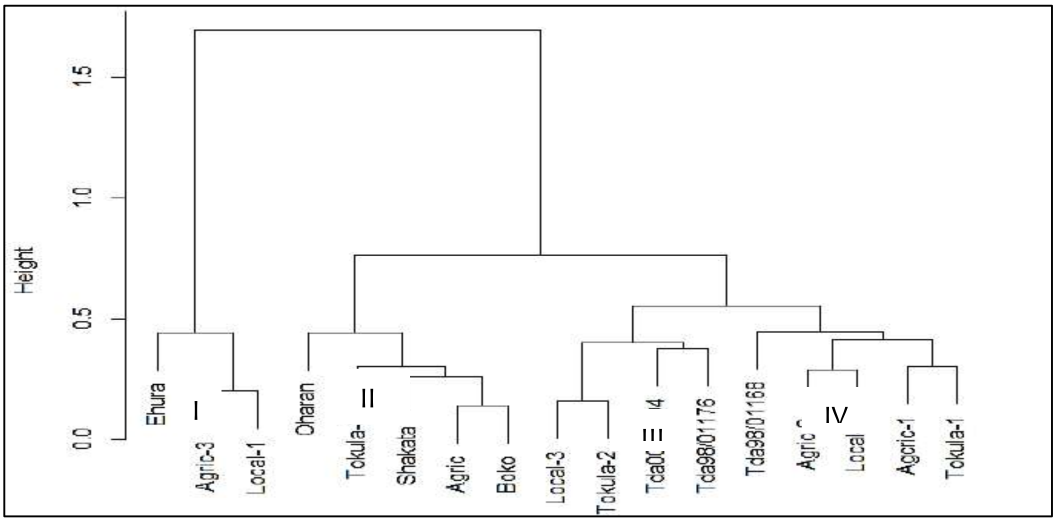

Figure 1: Dendrogram of 17 *D.alata* accessions developed from micro-satellite data using unweighted pair group of arithmetic means (UPGMA) based on Nei's (1978) genetic distance

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Selection of Hybrid White Yam Genotypes with Agronomic and Marketable Tuber Traits for Multilocational Trial

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Abstract
Eleven hybrid white yam genotypes plus three landraces of white yam were tested in the Western experimental field of N R C R I, Umudike in 2016 and 2017 with the objectives to identify and select superior high tuber fresh weight with desirable tuber characteristics for marketability and for possible commercial yam production. The experiment was laid out in a randomized complete block design with three replications in an area of land that was mechanically ploughed, harrowed and ridged at 1m apart. Yam setts weighing 40g were sown 45 cm apart on the crest of the ridges and 10 cm below the soil surface and 100cm between ridges in a plot size of 20m^2. Data were collected on: mean total fresh tuber weight, ware fresh tuber weight and weight of seed yams.. Data on tuber yield related market attributes such as tuber size, flesh tuber colour and tuber surface texture were collected. Result indicated that five hybrid yam genotypes 99/Amo/ 064, 99/Amo/109, 99/Amo/060, 99/Amo/080, and 99/Amo/144 were recommended for its high fresh tuber yield. They significantly (P<0.01) yielded more than Adaka (second Check variety) but lower than Ame (first Check variety) in their mean fresh tuber weight and mean fresh ware tuber yield in t/ha. They have high bulking rate an indication of fresh matter accumulation of usable carbohydrate. These genotypes have white flesh to cream colour, smooth skin and cylindrical shape (TSI = >1 and <4) marketability attributes that are acceptable to consumers. These genotypes are therefore selected for NCRP multi-location agro-ecological trial for yield stability trial.

Key words: Yam genotypes, fresh weight, high yield, tuber and consumer acceptability

Introduction
The white yam (*Dioscorea rotundata* Poir) is one of the most popular tuber crops in Nigeria and abroad because of its yield potential and high calorific value. It is mainly cultivated almost in all the tropical and subtropical countries. It is heterozygous cross-pollinated, polyploid (2n=90) and vegetatively propagated tuber (modified stem) crop in which many of the traits show continuous variation (Jones et al 1986). In addition to protein and starch some of the yam varieties provide micronutrients such as iron *making* the tuber more nutritious. Increasing total tuber yield would be made easier by selecting for components because the components are more simply inherited than the total tuber yield itself. Correlation studies enable the plant breeder to know the mutual relationship between various characters contributions and determine the component characters on which selection can be used for genetic tuber improvement. Although correlation coefficients assessment are helpful in determining the various component of complex traits like tuber yield although they do not provide an exact picture of relative importance of direct and indirect influence of each component character. The ultimate storage tuber yield depends upon a large number of factors such as environments and genetic constitution of the organism that influence the final expression of the tuber yield and tuber traits. Such a complex scheme of relationship could be partitioned by path coefficients analysis as suggested by Wright (1921) and adopted by Dewey DR and Lu (1981). Path analysis can be used to assist plant breeders to identify traits that are useful as selection criteria to improve crop yield. In Nigeria, yam is cultivated by subsistence farmers in densely populated high potential zones. In these areas, yields realized from the farmer's fields are very low between 3.5 to 5.0t/ha (Ezulike et al., 2006). This has been as a result of low yield from adapted varieties and poor agronomic practices. To increase productivity in such zones, there is need for the utilization of higher yielding varieties that are widely adaptable

across all the agro-ecological zones of the country and by use of application of appropriate agronomic practices (Daisy 2000). However, the aim of this study was to select high tuber yielding genotypes with tuber for marketability attributes for Nationally Coordinated Crop Release Project (NCRP) multlocational trial across the agro ecological zones for possible commercial yam production.

Material and Methods

The present study was conducted at the Western experimental field of N R C R I, Umudike in 2016 and 2017. The material used in the present study was developed through ontrolled pollinated breeding method. The true controlled pollinated seeds of Ten hybrid white yam genotypes plus two landraces of white yam were tested in the experiment which was laid out in a randomized complete block design with three replications in an area of land that was mechanically ploughed, harrowed and ridged at 1m apart. Yam setts weighing 40g were sown 45 cm apart on the crest of the ridges and 10 cm below the soil surface and 100cm between ridges in a plot size of 20m^2. The plots were kept weed-free manually. There was no Fertilizer application. Pre-emergence herbicide (Diuron) was used immediately after planting and complemented with manual weeding at 12 weeks after planting (WAP). Data on yield related components were collected such as: mean total tuber weight per tonne per hectare, ware tuber weight per tonne per hectare and weight of seed yams per tonne per hectare were collected. Data on other tuber yield related components such as tuber size, flesh colour and tuber surface texture were collected. Tuber yield was analyzed using Analysis of variance and means separation was done using standard error of difference means. Tuber surface Texture (TST). Visually scored. 1.0= smooth surface (skin) tuber, 2.0= rough surface (skin) tuber (IBPGR, 1997).

Results and Discussion

Mean Fresh weight of tubers per plant: Tuber fresh weight is the accumulation of fresh matter content in the tubers of the hybrid yam genotypes. The result on mean total weight of fresh tubers, mean weight of ware fresh tubers, mean weight of fresh seed tubers and other tuber yield attributes for fresh tuber marketability are presented on Table 1.

Table 1: Mean total fresh tuber weight (t/ha), mean Fresh weight of ware yam (t/ha), mean fresh weight of seed yam (t/ha) and other related attributes for tuber marketability and agronomic traits of the yam genotypes for the two seasons combined

Clonal name	Mean Total fresh tuber weight t/ha	Mean Fresh weight of ware yam (t/ha)	Mean Fresh weight of seed tubers (t/ha)	Tuber flesh colour	Rate of oxidation < 5minutess	Type of ooze on cut surface	Tuber skin thickness
99/Amo/064	36.6	16.6	23.0	White	Low	Gummy	>1mm
99/Amo/109	47.8	18.4	29.4	White	Low	Gummy	>1mm
99/Amo/060	35.2	19.2	16.0	White	Low	Gummy	>1mm
99/Amo/080	31.2	14.8	16.4	Cream	Low	Gummy	>1mm
99/Amo/144	39.0	20.4	18.6	White	Low	Gummy	>1mm
99/Amo/040	23.0	9.8	13.2	White	Slight < 5	Gummy	>1mm
99/Amo/17	18.0	0.0	0.0	white	Low	Gummy	>1mm
99/Amo/056	34.6	21.8	12.8	Cream	Low	Gummy	>1mm
99/Amo/95A	27.4	8.4	19.0	White	Slight < 5	Gummy	>1mm
99/Amo/003	24.4	11.6	12.8	White	Low	Watery	>1mm
99/Amo/x5	7.0	2.6	4.4	White	Low	Watery	>1mm
Ame	35.0	15.0	20.0	White	Low	Gummy	>1mm
Nwopoko	24.0	16.0	8.0	White	Low	Gummy	>1mm
Adaka	28.2	13.0	5.2	White	Low	Gummy	>1mm
Std error	17.6	7.3	6.4				
Range	7.0-47.8	2.6-21.8	0.0-29.3				
Mean weight	32.9	15.1	17.2				
Sig. level	P<0.01	P<0.01	P<0.01				

Note: Seed yam =Yam tubers weighing less than 1000g Ware yam= tubers weighing above 1000g

Total mean tuber fresh weight of the yam genotypes significantly (P<0.01) varied among the hybrid yam genotypes. The mean total tuber fresh tuber weight varied from 7.0 (99/Amo/x5) to as high a 39.0t/ha with grand mean of 32.9t/ha. However, six yam genotypes had fresh tuber weight above the grand mean. Nevertheless, five genotypes namely; 99/Amo/064 (36.6t/ha), 99/Amo/144 (39.0t/ha), 99/Amo/109 (47.8t/ha), 99/Amo/060 (35.2t/ha), 99/Amo/056 (34.6t/ha) had more tuber fresh weights higher than the highest yielding check variety Ame with 35.0t/ha. The fresh weight of ware yam tubers significantly (P<0.01) varied among the yam genotypes evaluated in the range of 2.6t/ha (99/Amo/x5) to as high as 29.3t/ha (99/Amo/109).Ware yam tubers are tubers for commercial yam production and for consumption. It is further differentiated into Table tubers (>1.0 < 3.0kg) and ceremonial tubers (>3.0kg). Yam genotypes that produces more fresh ware yam tubers than the check varieties should be selected for evaluation across the yam growing agro-ecologies of the country for yield stability trial. Based on this result, the following yam genotypes that produced ware yam tubers with fresh weight higher than the check varieties should be selected; 99/Amo/ (21.8t/ha), 99/Amo/144 (20.4t/ha), 99/Amo/060 (19.2t/ha), 99 Amo/109 (18.4t/ha), and 99/Amo/064 (16.6). The seed tubers are for planting commercial ware yam production. The result on Table 2 indicated high significant (P<0.01) variability in the fresh weight of seed yam tubers produced by the yam genotypes. The fresh weights of the seed tubers varied from 0.0 (99/Amo/017) to as high as 29.3t/ha (99/Amo/109) with grand mean of 17.2t/ha. Yam genotypes with seed tubers whose fresh weights were above the grand mean should be selected for commercial seed tuber production (Table 2). However, the following yam genotypes 99/Amo/144, 99/Amo/060, 99/Amo/109 and 99/Amo/064 had tubers with more total fresh tuber weight, weight of ware tubers and weight of seed tubers.

Marketability attributes

Tuber size: The results on Fresh tuber length, Tuber width and other tuber related market attributes of the yam genotypes are presented in Table 2.

Table 2: Fresh tuber length, Tuber width and other tuber related market attributes of the yam genotypes

Clone name	Maximum tuber length	Maximum tuber width	Tuber shape index	Tuber skin texture	Tuber hairiness	Tuber spineness
99/Amo/064	28.50	7.45	3.80	1	1	1
99/Amo/109	29.00	7.98	3.63	1	1	1
99/Amo/060	28.10	8.20	3.43	1	1	1
99/Amo/080	31.53	10.0	3.16	1	1	1
99/Amo/114	28.91	8.21	3.52	1	1	1
99/Amo/040	27.60	7.33	3.87	1	1	1
99/Amo/17	30.00	7.55	3.97	1	1	1
99/Amo/056	34.30	9.19	3.73	1	1	1
99/Amo/95A	22.93	7.98	2.90	1	1	1
99/Amo/003	28.20	7.87	3.60	1	1	1
99/Amo/X5	26.13	6.83	3.80	1	1	1
Ame	29.38	8.31	3.50	1	1	1
Nwopoko	29.34	7.6	3.86	1	1	1
Adaka	29.38	8.31	3.50	1	1	1
Std error	5.6	2.9	3.54			
Range	22.93-30.0	6.83-10.0	3.16-3.97			
Mean	28.81	8.06	3.84			
Sig. level	P<0.05	P<0.05	P>0.05			

Note: Tuber surface Texture (TST): 1.0= smooth surface (skin) tuber, 2.0= rough surface (skin) tuber

The results indicated the mean tuber size of the 14 yam genotypes in terms of bulkiness. There was significant (P<0.05) variation in the length and width of the hybrid yam genotypes. The significant (P<0.05) genotypic mean tuber size variation among the hybrid yam genotypes which ranges from 22.93cm to 30.0cm in length and 3.16 to 8.97cm in width indicated the extent of fresh carbohydrate accumulation and the rate of photosynthetic efficiency among the genotypes. The length and width of the tubers measures the tuber size which is the dimension, extent or how large the yam tubers were. The yam genotype with the longest tuber length was 99/Amo/056 with 34.30cm and tuber thickness of 9.19cm more than the two landraces (Table 2) which indicated high fresh carbohydrate accumulation and more photosynthetic efficiency more than the three landraces. Other genotypes with long tubers and larger width more than the landraces were 99/Amo/080 with length 31.53cm and width 10.0cm. This indicated high bulking rate of the hybrid yam genotypes. Consumers who need yam for consumption buy ware yam tubers that are large.

Tuber shape: The hybrid yam genotypes and the landraces have straight sides with almost circular ends of equal size and a constant circular cross section that can go for as cylindrical shape. This type of shape is not prone to damage during yam harvest and easy for tying on stakes during storage. Branched yam tubers are liable for damage during harvesting. All the yam genotypes including the landraces have cylindrical shapes. Hence the tuber shape index is within region of general acceptance (TSI = >1 and < 4). The mean tuber shape of all the hybrid clones was 3.84 which is an indication of cylindrical shape. This shape lends itself for ease of peeling during processing for food than round or flat shape. Yam tuber with cylindrical shape command high market prices. However, yam tubers with cylindrical shape grow deeper into the soil and less prone to breakage during harvesting (Orkwor et al, 2000).

Tuber surface texture: The tuber surface texture indicates the tubers surface appeal to the eye which could influence their marketability. The result in Table 2 indicated that the tubers surface texture indices were fine. The score rating of 1.0 for hairiness, spines and surface skin texture indicated that they were all good and appealing and could enhance their marketability. .

Tuber flesh colour: The tuber flesh colour ranges from cream to white (Table 2) with very low oxidation rate after being exposed to the air for 5 minutes. Two genotypes Amo99/040 and Amo99/095A slightly turned brown after being exposed to the air for 5 minutes. Colours are good index for the acceptability or rejection of yam genotypes especially if the yam genotypes are for food preparation such as pounding of *fufu.* All the yam genotypes evaluated have white flesh colour which could be good for *fufu* food. Yam tubers with white flesh colour attract and appeal to the eyes and therefore contribute to the marketability of the tubers than yam tubers that are brownish in colour. The tuber flesh colour of the hybrid yam genotypes including the landraces were all white in colour and would be good in yam flour or in the preparation of pounded yam a prestigious carbohydrate to welcome visitors especially in South eastern Nigeria. The exudates of the genotypes are gummy and non-irritant when it comes in contact with the human skin except Amo99/003 and Amo99/X5 (Table 2) which have watery exudates. Yam tubers that are irritating to the skin does not appeal to consumers except if it has special attributes.

Tuber skin thickness: Tubers that are liable to bruises as a result of light skin does not store well. The bruise is an entrance to pathogenic organisms. Yam genotypes with skin tuber surface above 1.0mm does not bruise easily during harvest and while carting for storage or other minor handlings.

Conclusion

Five hybrid yam genotypes 99/Amo/064, 99/Amo/109, 99/Amo/060, 99/Amo/080, and 99/Amo/144 are hereby recommended for its high tuber yield. They yielded more than Adaka (second Check variety) but lower than Ame (first Check variety) in their mean total fresh tuber yield and mean fresh ware tuber yield in t/ha. They have high bulking rate an indication of accumulation of usable fresh carbohydrate. These genotypes have white flesh to cream colour, smooth skin and cylindrical shape (TSI = >1 and <4) that is acceptable to consumers and command high market value as a result of tuber surface skin texture.

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Response of Promiscuous Soybean to Bio-Fertilizer with Organic and Mineral Fertilizers in Some Soils of Nigerian Guinea Savanna

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Abstract
Effective soybean rhizobia are seldom found in sufficient or large numbers in the soils that have no history of soybean cultivation. There may be a need for soybean grown in such soils to be supplied with inoculant rhizobia to ensure optimal inputs from biological nitrogen fixation. A trial was set up to diagnose the underlying factors responsible for variation in yield among soybean treatments at four sites in Shiroro Local Government Area of Niger State. The trial consisted of six (6) treatments and four (4) replications arranged in randomized complete block design (RCBD). The treatments were (I) Control, (II) Inoculant only, (III) Inoculant + phosphorus (30kg P_2O_5/ha), (IV) Inoculant + phosphorus + potassium (20kg K_2O/ha), (V) Inoculant + phosphorus + potassium + micronutrients (3.3kg/ha) and (VI) Inoculant + phosphorus + potassium + micronutrients + organic manure (4tons/ha). Response to bio-fertilizer varied across sites. Treatments with organic matter were significantly greater than the control in terms of plant height, nodule number and shoot dry weight but marginally greater than the control in pod number and pod dry weight. The treatments with inoculant only had similar yield parameters as the mineral fertilizer treatments as well as the organic matter treatments. The results indicate the benefit of using bio-fertilizers and organic matter in improving the productivity of soybean.

Introduction
Soybean is an introduced crop in Nigeria. Its production in Benue State, which is the largest producer of the crop in Nigeria, is about 175, 000 metric tonnes (MT) out of the estimated national production of about 437,000 MT in 2007 (FMAWR,2007; NFRA, 2008). Average yields in Nigeria are estimated at less than 500 kg/ha (NPAFS, 2009) although up to 3–4t/ha are obtained in some other countries (DAFF, 2010). Low soil fertility, especially deficiencies of N, P, K and some micro nutrients such as zinc and boron have been reported as a major factor hindering soybean productivity. Soybean like other N_2 fixing legumes, can meet part of its N requirement through biological nitrogen fixation (BNF). The TGx soybean varieties commonly grown in Nigeria were developed by the International Institute of Tropical Agriculture (IITA) Ibadan to form nodules freely with indigenous rhizobium in tropical soils (Kueneman *et al*., 1984; Pulver *et al.,* 1985). However these crops do not form effective symbiosis with indigenous rhizobia populations in all cases and do often benefit from inoculation using highly effective rhizobia strain (Pulver, *et al.*, 1985). Organic manure provides a good substrate for the growth of microorganisms and maintains a favorable nutritional balance and soil physical properties. The uses of organic matter for enhanced fertility and crop productivity is generally recognized providing most of the nutrient requirement by crops (Asei, *et al.,* 2015). However, given the limitations in its availability and ease of handling, one strategy to maintain soil fertility for sustainable production of soybean is through the judicious use of mineral fertilizers coupled with organic resources (Bobde *et al.,* 1998). There is a dearth of knowledge on the use of organic matter in soybean production within the Nigerian guinea savanna. The objective of this study, therefore, was to study the additive effect of phosphorus, Potassium, Micronutrients, Organic manure and Inoculant on the productivity of soybean.

Materials and Methods

Sites

The trial was conducted on farmers' fields located at four different sites, Kuta, (latitude N 9° 53′ 8″& Longitude E 6° 42′ 18″) Gupe, (Latitude N 9° 48′ 13″ & longitude E 6° 41′ 15″) Webwo, (Latitude N 9° 49′ 36″ & Longitude E 6° 45′ 49″) and Kukulu (Latitude N 9° 40′ 47″& Longitude E 6° 44′ 30″) in Shiroro Local Government Area of Niger State, Nigeria.

Land Preparation

The fields used for this trial were sprayed with herbicide (Paraquat). Then the field was marked, and the plots measured 10m x 10m. Each plot contained 14 ridges spaced at 0.75m interval with plots separated by 0.5 m alleys.

Source of Seeds, Inoculant and Fertilizers

Seeds, inoculant and fertilizers were all obtained from International Institute for Tropical Agriculture (IITA) Ibadan. Promiscuous soybean variety TGx 1951-3F was used for the trial. The inoculant was Legumefix, a peat based inoculant containing *Bradyrhizobium* Sp. Strain 532c. Phosphate fertilizers was Single super phosphate (SSP) while Potassium was supplied using Muriate of Potash (MOP).

Experimental Design and Treatment

The experiment was laid out in a Randomized complete block design, consisting of six (6) treatments and four (4) replications. The treatments were

(i) Control, (No Input)
(ii) Inoculant only,
(iii) Inoculant + phosphorus (30kg P_2O_5/ha),
(iv) Inoculant + phosphorus + potassium (20kg K_2O/ha),
(v) Inoculant + phosphorus + potassium + micronutrients (3.3kg/ha) and
(vi) Inoculant + phosphorus + potassium + micronutrients + organic manure (4tons/ha).

Sowing and Fertilizer Application

Soybean seeds were directly sown by dibbling two seeds per hole into the soil at 10cm intra row spacing. Fertilizer application was carried out at planting and the organic manure application was done two weeks before planting.

Data Collection

Plant height was measured at 6 weeks after sowing (WAS). Plant shoot was sampled at mid-podding, oven – dried at 70°C for 2days to get the shoot dry weight. Pods were sampled at physiological maturity and oven dried at 70°C for 2days. 100 seed weight and total grain weight was taken at harvest.

Statistical Analysis

Data were subjected to analysis of variance (ANOVA) and the means separated using the New Duncan Multiple Range Test (DMRT).

Results and Discussion

Plant Height

Inoculation and progressive addition of mineral fertilizers only led to marginal increase in height above that of the Control (fig 1). Only a combination of these amendments and organic matter led to a significant increase in height above the control. The organic matter treated plants were only marginally taller than plants treated with other fertilizers.

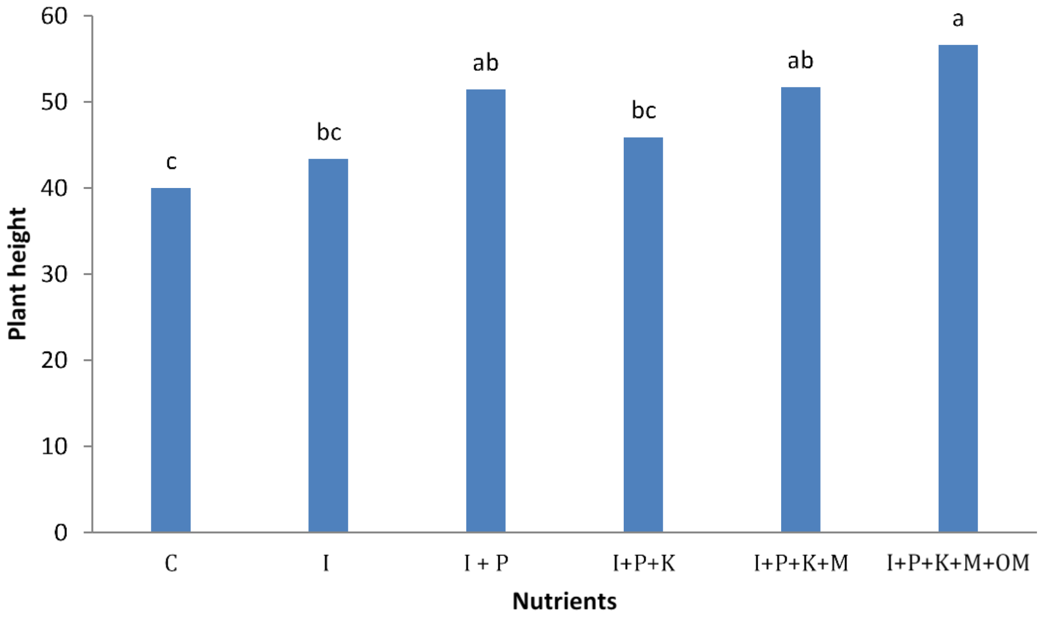

Fig. 1. Effect of nutrient combination on plant height of soybean
C- control, I – inoculant, P – phosphorus, K – potassium, M – micronutrient, O – organic manure

Number of Branches
Branch numbers of treatment with organic manure was marginally greater than the control but was not statistically different from treatments with inoculant only, Inoculant + P, and I+P+K+M, treatment with I+P+K saw statistically the same as I+P+K+M+OM.

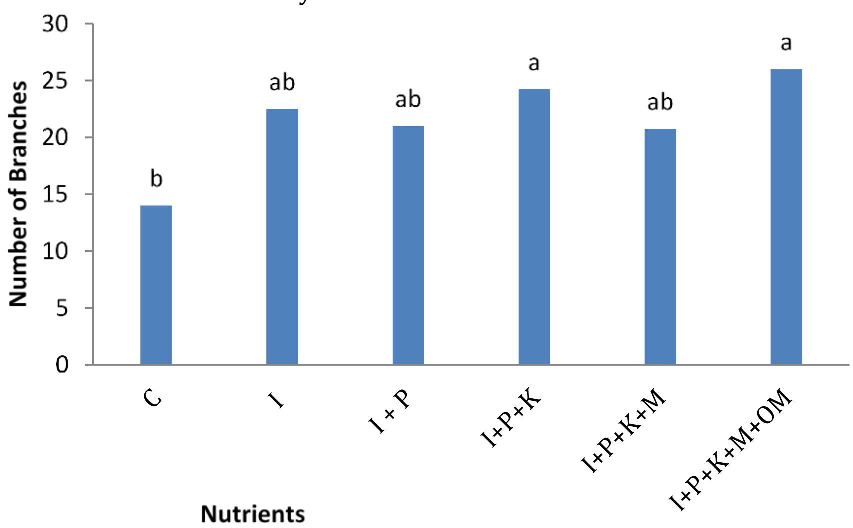

Fig. 2. Effect of nutrient combination on Number of Branches per plant of soybean
C- control, I – inoculant, P – phosphorus, K – potassium, M – micronutrient, O – organic manure

Shoot Dry Weight
Shoot dry weight of plants treated with inoculant only was marginally greater than the Control plants and similar to other treatments (fig 2). The only treatment that resulted in significantly

larger biomass than the Control was the treatment that was supplied with inoculant and all the mineral fertilizers.

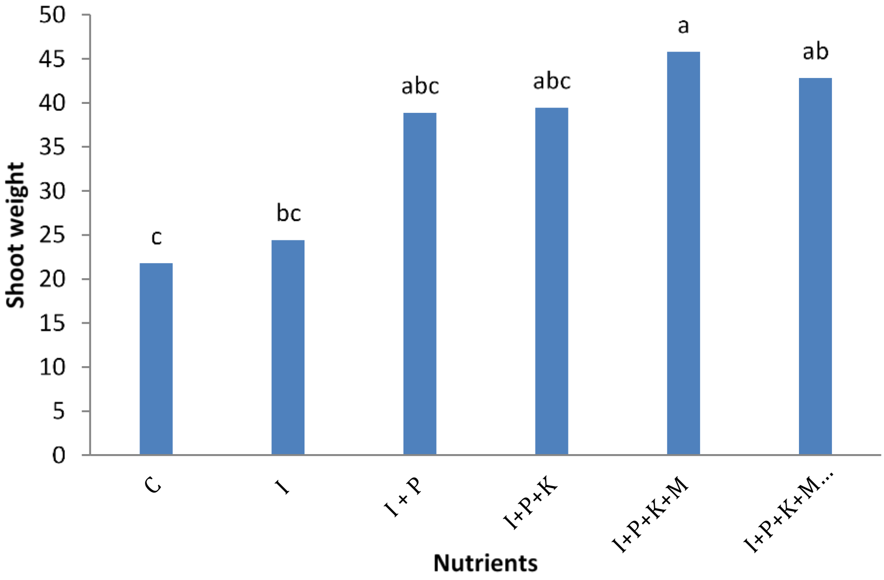

Fig. 3. Effect of nutrient combination on Shoot weight per plant of soybean
C- control, I – inoculant, P – phosphorus, K – potassium, M – micronutrient, O – organic manure

Nodule number

Treatment containing Inoculant and Phosphorus gave the highest number of nodules compared to Control which had no nutrient application. Abdul and Saud,(2012) reported that the number of bacterial nodules increased significantly in plants inoculated with UPMR020, compared with non-inoculated plants.

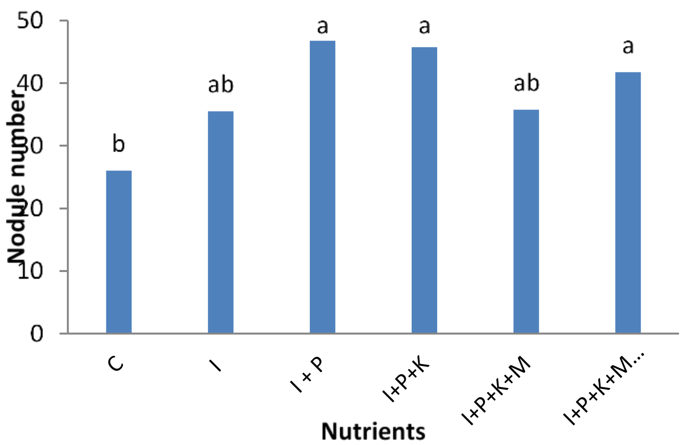

Fig. 4. Effect of nutrient combination on Nodule number per plant of soybean
C- control, I – inoculant, P – phosphorus, K – potassium, M – micronutrient, O – organic manure

Pod number

Number of pod increased as inputs were added. Treatment with inoculant, phosphorus, potassium, micronutrient and organic matter had the highest number of pods per plant compared to the control. Abdul and Saud,(2012) reported that the effect of bacterial inoculation increased the number of pods under inoculation treatments. This can be compared with non-inoculation at (P ≤0.01), which gave 27.50 pods /plant for inoculation and 6 pods /plant for control.

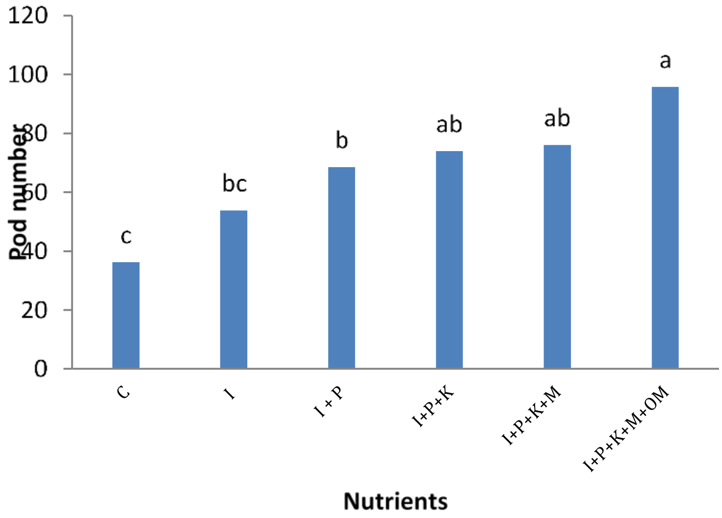

Fig.5. Effect of nutrient combination on pod number per plant of soybean
C- control, I – inoculant, P – phosphorus, K – potassium, M – micronutrient, O – organic manure

Weight of dry pod/plant

The treatment with organic matter had the highest weight of dry pod per plant compared to the control. Abdul *et al*, (2012) said the lowest amount of pod weight was shown by control treatment. The results suggested the importance of inoculation with Rhizobium to increase pod weight (P≤0.01).

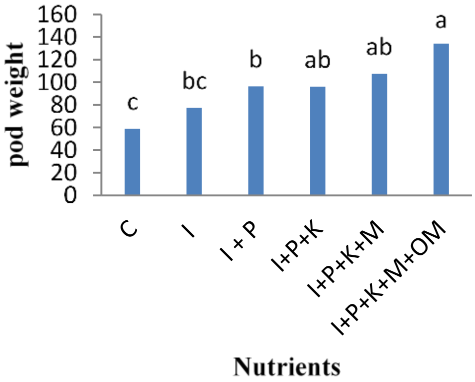

Fig.6. Effect of nutrient combination on pod weight per plant of soybean
C- control, I – inoculant, P – phosphorus, K – potassium, M – micronutrient, O – organic manure

Grain Yield
Inoculation and progressive addition of mineral fertilizer marginally increased grain yield. The addition of organic manure gave the highest grain yield, greater than the control.

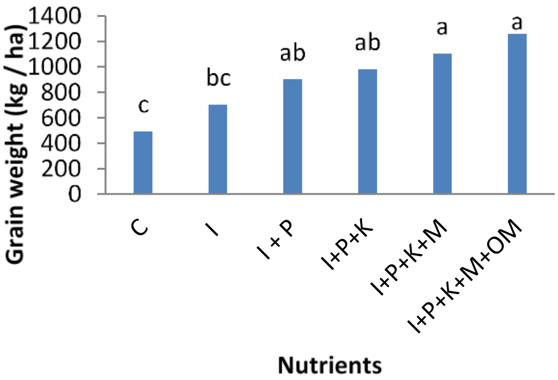

Fig.8. Effect of nutrient combination on grain weight of soybean
C- control, I – inoculant, P – phosphorus, K – potassium, M – micronutrient, O – organic manure

Nodulation, yield and other yield parameters of soybean plants that were treated with bio-fertilizer only were not significantly different from those of the control plants, suggesting that application of bio-fertilizer alone in low fertility soils may only result in marginal benefit to the soybean plant. Application of P or P and /K only led to marginal increases except in the case of nodule number. This is contrary to results of previous studies that reported significant increase in yield due to the inoculation and P addition. Legumes have a high requirement for O as a result of the pronounced effect of the element. crop quality and yields of crops (Taiwo et al, 1999; Asia et al., (2005) Abdul and Saud (2012) observed a significant increase in number of nodules and pod number and pod weight as a result of inoculation with bio-fertilizer. Rhizobial inoculation has also been shown to result in significant increase in yield and yield parameters of promiscuous soybean in some soils of the Nigerian savanna. (Osunde et al., 2003) although not in all cases. (Okereke and Eaglesham, 1993). The lack of any significant increase in yield /parameters as a result of the addition of micronutrient blend suggest that the micronutrient content in soils at the site where the trial were carried out was adequate. However, studies have indicated the occurrence of micronutrient deficiency in some soils of the Nigerian savanna, especially zimc, copper and boron (Oluwadare et al., 2013; Oyinlola, 2007). Addition of organic matter led to most yield and yield parameters being significantly greater than those of the control, suggesting its beneficial effect in nutrient supply. The fact that organic matter was necessary for significant increase in yield parameters to be achieved is an indication that either one of P,K or micronutrient fertilizers or their combination were not sufficient for the crop at the rates applied or some other nutrients were limiting, which were supplied by the organic matter. Agrolyzer the micronutrient blend used to supply micronutrients in the current experiment, does not contain boron. Given that boron is one of the elements commonly cited to be deficient in savanna soils (Oyinlola, 2007). It is probable that the significant increase in yield parameters due to the application of organic matter maybe because of the boron supplied by the organic matter.

Conclusion

Use of organic manure and bio fertilizer could improve the productivity of soybeans. Given the status of organic matter as contributor of fertility, the use of the other mineral fertilizer may not be necessary however the quality of the organic manure may need to be confirmed or accessed.

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Evaluation of some Agronomic and Seed Traits in Bambara Groundnut (*Vigna subterranea*[L.]Verdc.) Accessions

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Abstract
Bambara groundnut (Vigna subterranea[L.]Verdc.) is an indigenous neglected and underutilized legume adapted to a wide range of conditions. It is a major source of protein grown commonly by resource poor farmers at subsistence level in Nigeria. However, few studies have been conducted to investigate the variability present in the bulk of available landraces. The study was aimed to characterize 20 accessions of bambara groundnut using some quantitative traits useful for selection. Data on days to first and 50% flowering, plant height (cm), number of pods per plant, dry weight of pods, seed weight, 100-seed weight and shelling percantage were collected and subjected to analysis of variance using SAS version 9.1. Highly significant (P<0.01) differences were observed among these landraces for all the traits. This result suggests that effective selection among these landraces can be made for both production and genetic improvement purposes.
Key words: Accessions, Bambara groundnut, Genetic improvement, Quantitative traits, Shelling percentage

Introduction
Bambara groundnut, also known as 'Okpa' (Igbo), 'gurjiya' or 'kwaruru' (Hausa) and 'Eparoro' (Yoruba), is an annual legume which belongs to the family *Fabaceae* with 2n = 22 chromosome number. The crop has an African species which is mostly grown in West Africa, but occasionally grown in Asia. Bambara groundnut is often called complete food because the seeds contain sufficient quantities of protein, carbohydrate and fat (NRC, 2006). Thus, it compares well with more commonly consumed and commercialized grain legumes such as cowpea and groundnut. Bambara groundnut as a legume crop is a cheap source of protein and minerals in many African countries where animal protein is very expensive. It fixes atmospheric nitrogen into the soil through symbiotic relationship with *Rhizobium* bacteria. The crop is mainly cultivated using landraces (Akpalu *et al*., 2013). Great variability exists in the growth and developmental characteristics of individual plant within a landrace collection (provenance) (Squire *et al*., 1996; Massawe, 2000). The landraces comprise of mixtures of different morpho-types which are distinct in physical appearances (coat color and pattern and helium) and performance, as well as product value (Akpalu *et al.*, 2013).

In spite of the importance of Bambara groundnut, it has not received the desired attentions by research community both at National and International levels. It is a common knowledge that the determination of genetic diversity among new collections is a pre-requisite for its effective utilization for crop improvement purposes This is necessary to provide information on traits useful for effective utilization by end-users (IPGRI, 2009).Therefore, this study was conducted to identify superior genotypes from the collected Bambara groundnut accessions.

Materials and Method
The research was conducted at the Institute for Agricultural Research (IAR), Samaru Research Farm, Ahmadu Bello University, Zaria, (Lat 11° 11' N; Long 7°N 38 'Altitude 660 m above sea level) in the northern guinea savanna of Nigeria with a mean annual rainfall of about 1200 mm annua,l which was essentially between March and April. The mean daily temperature during the

growing period was 27°C. Seeds of 20 homogenous accessions of Bambara groundnut landraces obtained from Gargai and Kura in Kano State were used for the study (Table 1). The 20 Bambara groundnut accessions were planted out in a randomized complete block design with three replications. In each replication, two rows of 5m represent a plot for each accessions, and each of the accessions was assigned randomly to the plots. Seeds were sown at 40 cm × 75 cm intra and inter row spacing, respectively making a total of 12 stands on each row. Sowing was done on the 15 July, 2016. Field management practices were employed to keep a healthy crop, including weeding and general field sanitation. Data were collected on: days to first flowering, days to 50% flowering, plant height (cm), number of branches per plant, number of pods per plants, pod weight (g) per plant, seed weight per plants (g), 100S=100 seed weight (g) and shelling percentage (%). Collected data were subjected to analysis of variance using statistical analysis system software (SAS 9.1 version) to determine if variation existed among the landraces. The means of each trait for the landraces were separated using LSD $_{0.05}$.

Results and Discussion

There were highly significant ($P<0.01$) differences among all the accessions for all the traits under study (Table 3). The estimate of coefficient of variation (CV) was used to compare the extent of variability within each trait. Out of the 20 accessions, number of pods exhibited the highest variation with the CV of 17.97%, followed by total weight of seeds/plant (CV=10.92%). The lowest variation was recorded in days to first flowering (2.71%). For days to first flowering, Accession 7 flowered earliest at 36 days after sowing (DAS), while Accession 20 (40.50 days) was the latest to flower. Accession 7 was also the first to attain 50% flowering (38.83 DAS), whereas, Accession 20 (45 days) was the latest to attain 50% flowering. Ouedraogo*et al*. (2008) reported a range of 30-33 DAS for first flowering among Bambara groundnut accession evaluated in Burkina Faso. This study was in agreement with the work of Molosiwa (2012) who observed significant differences for similar traits studied among accessions grown in the UK, with the exception of days to maturity. This result indicated the usefulness of genotype characterization for purposeful selection of desirable genotypes especially for breeding. Investigations in the present study showed high variations in the number branches than those reported by Molosiwa (2012) (33), Amadou *et al*. (2015) (38) and Mwangwela *et al*. (2009) (53) among Bambara groundnut accession. Accession 20 had the highest plant height of 31.44cm and number of branches of 217. Variations in heights were observed in works of Amadou *et al*. (2015), Ouedraogo *et al*. (2008) and Shegro *et al*. (2013). Highest weight of pods (288.33g) and number of pods per plant (138.72) were recorded in Accession 20. The highest mean values for seed weight per plant (74.12g) and 100 seed weight (142.67g) were recorded in Accession 20 and 14, respectively. Accession 13 had the least seed weight per plant (24.93g), while Accession 19 gave the least weight of 100 seeds (41.6g) (Table 3). Molosiwa (2012), Amadou *et al*. (2015) and Ouedraogo *et al*. (2008) recorded similar variations in their Bambara groundnut characterization studies for 100 seed weight. Shelling significantly varied in this study. It is the measure of the proportion of seeds in relations to the pod as percentage. The ranges in values of shelling percentage of the accession were in agreement with those reported by Ouedraogo *et al*. (2008). Squire *et al*. (1996) and Massawe (2000) reported wide variability in the growth and yield traits of individual plants of Bambara groundnut landraces.

Conclusion

There was wide variability among the 20 accessions of the Bambara groundnut studied as explained by their mean performance. Accession 20 performed best in almost all the traits except for 100-seed weight and could be a good candidate for farmers if its culinary attributes are accepteable. However, further field trials in more locations need to be conducted to determine which genotypes could best fit which environment, and to assess the effect of environment on the expression of the traits.

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Table 1: Seed physical characteristics of the 20 accessions of Bambara groundnut used in the study

Accession ID	Seed shape	Background color	Eye pattern
Accession 1	Oval	Cream	Brown
Accession 2	Oval	Black	Cream eye
Accession 3	Round	Cream	Purple big eye
Accession 4	Oval	Cream	Marble eye
Accession 5	Oval	Cream	Black irregular eye
Accession 6	Round	Cream	Brown small eye
Accession 7	Round	Brown	Brown circular eye
Accession 8	Oblong	Cream	Black butterfly eye
Accession 9	Oval	Light brown	Grey butterfly eye
Accession 10	Oval	Purple	Light brown eye
Accession 11	Oval	Cream	Brown eye
Accession 12	Oval	Cream	Greyed black
Accession 13	Round	Light brown	Grey small eye
Accession 14	Oblong	Cream	Brown
Accession 15	Round	Cream	None
Accession 16	Round	Cream	None
Accession 17	Round	Cream	Black eye
Accession 18	Oval	Red	None
Accession 19	Round	Brownish-cream	Black
Accession 20	Oval	Light brown	Grey

Table 2: Analysis of variance for 20 of Bambara Groundnut accession evaluated for 11 quantitative traits at Samaru in 2016

Source of variation	DF	FFL	DFF	PHT	NOP	PWT	SWT	100S	SH%
Replication	2.00	5.22	2.28	2.48	75.34	188.18	16.24	19.70	70.64
Accessions	19	3.67**	6.97**	8.12**	2792.18**	445.52**	333.42**	2208.78**	157.20**
Error	38.00	1.12	6.52	1.30	133.91	49.85	4.68	5.70	38.85
CV (%)		2.71	2.82	4.20	17.97	9.52	4.82	2.84	10.31

**Significant at P<0.01
Legend: FFL=Days to first flowering, DFF=Days to 50% flowering, PHT=Plant height (cm), NOP= Number pods per plants, PWT=Pod weight per plant, SWT= seed weight per plants (g), 100S=100 seed weight (g) and SH%=Shelling percentage(%).

Table 3: Mean Performance of some agronomic and seed yield traits among 20 accessions of Bambara groundnut used in the study

Accession ID	FFL	DFF	PHT	NOP	PWT	SWT	100S	SH%
Accession 1	40.33^{a}	43.33^{abcd}	27.19^{cdefg}	127.43^{ab}	65.33^{fg}	43.34^{hg}	47.40^{o}	66.67^{abc}
Accession 2	39.00^{abcd}	42.33bcdf	26.91^{defg}	58.75^{c}	80.75^{bcde}	53.90^{b}	84.80^{ijk}	67.96^{abc}
Accession 3	39.50^{abcd}	42.67^{abcde}	25.59^{fgh}	44.49^{c}	71.67^{defg}	37.82^{ij}	85.60^{hij}	53.58^{def}
Accession 4	39.67^{abc}	42.83^{abcd}	27.19^{cdefg}	53.81^{c}	75.05^{bcdef}	44.54^{fg}	81.10^{lk}	59.55^{cde}
Accession 5	39.17^{abcd}	42.50^{bcdef}	25.38^{fgh}	60.19^{c}	85.65^{bc}	48.93^{de}	90.20f^{g}	57.60^{cdef}
Accession 6	38.50^{abcd}	41.00^{def}	27.40^{bcdef}	59.80^{c}	82.19^{bcd}	49.12^{de}	79.33^{l}	61.35^{abcde}
Accession 7	36.50^{e}	38.83^{g}	26.65^{defgh}	49.41^{c}	62.10^{fg}	40.10^{hi}	62.63^{n}	64.87^{abcd}
Accession 8	37.50^{de}	40.50^{efg}	28.52^{bcd}	45.02^{c}	81.73^{bcd}	53.47^{bc}	114.33^{c}	65.44^{abcd}
Accession 9	39.50^{abcd}	44.17^{ab}	27.95^{bcde}	56.03^{c}	86.15^{b}	52.47^{bcd}	101.13^{e}	61.17^{bcde}
Accession 10	38.50^{abcd}	40.33^{fg}	26.21^{efgh}	49.57^{c}	80.11^{bcde}	49.73^{cde}	106.53^{d}	62.17^{abcde}
Accession 11	39.50^{abcd}	43.50^{abc}	24.98^{gh}	48.13^{c}	64.19^{fg}	32.27^{k}	70.80^{n}	50.28^{ef}
Accession 12	37.67^{cde}	42.83^{abcd}	28.00^{bcde}	39.13^{c}	66.58^{fg}	34.21^{jk}	130.27^{b}	51.46^{ef}
Accession 13	38.00^{bcde}	43.00^{abcd}	26.10^{efgh}	44.53^{c}	44.72^{h}	24.93^{l}	87.13^{ghi}	56.34^{cdef}
Accession 14	38.00^{bcde}	41.50^{bcdef}	27.57^{bcdef}	41.08^{c}	80.56^{bcde}	41.19^{ghi}	142.67^{a}	51.56^{ef}
Accession 15	39.17^{abcd}	43.38^{abc}	26.78^{defgh}	51.70^{c}	82.70^{bcd}	47.65^{ef}	91.77^{f}	57.50^{cdef}
Accession 16	39.50^{abcd}	44.33^{ab}	24.67^{h}	51.88^{c}	60.18^{g}	38.55^{i}	82.13^{jk}l	64.13^{abcd}
Accession 17	40.33^{a}	43.83^{abc}	26.20^{efgh}	47.22^{c}	72.10^{cdefg}	34.10^{jk}	89.57^{fgh}	47.52^{f}
Accession 18	39.50^{abcd}	43.00^{abcd}	29.20^{bc}	109.89^{b}	72.80^{bcdefg}	52.68^{bcd}	48.23^{o}	72.39^{ab}
Accession 19	40.00^{ab}	43.33^{abcd}	29.53^{b}	111.22^{b}	67.45^{efg}	43.47^{gh}	41.60^{p}	64.50^{abcd}
Accession 20	45.50^{a}	45.00^{a}	31.44^{a}	138.72^{a}	101.19^{a}	74.12^{a}	45.77^{o}	73.38^{a}
SEM±	0.61	0.69	0.65	6.68	4.08	1.25	1.38	3.60

Means with the same letter within a column are not significantly different at P<0.05
Legend: FFL=Days to first flowering, DFF=Days to 50% flowering, PHT=Plant height (cm), NOP= Number of pods per plants, PWT=Pod weight per plant, SWT= seed weight per plants (g), 100S=100 seed weight (g) and SH%=Shelling percentage (%).

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Genotypic and Phenotypic Analysis of Four Cotton Hybrids for Yield and Fibre Quality Traits

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Abstract
The purpose of this study was to investigate the phenotypic and, genotypic variances, nature and magnitude of gene effects for seed cotton yield and fibre quality traits in four inter-varietal hybrids of cotton. All the hybrids demonstrated significant mid parent and better parent heterosis. Most recessive alleles for seed cotton yield per plant accumulated in KC2 x TCB26 which expressed maximum negative degree of dominance. The highest heterotic expression for seed cotton yield over standard check was 9.03% exhibited by TCH1705-101 x TCB209. The highest values for genetic advance were by TCH1716 x TCB37, TCH1705-101 x TCB209 and TSH0250 x DB3 for number of sympodial branches per plant. Hybridization and effective selection for all the characters would be of great benefit in a breeding program.

Introduction
Cotton is an important natural fibre crop of global importance grown commercially in about 111countries with a global area of 30.29 million hectares accounting for 105.06 million bales (217.724 kgs) of production with a productivity of 755 kg/ha (Magadum _et al_., 2012). In Nigeria, cotton plays a key role in the national economy by its contributions in trade, industry, employment and foreign exchange. Several breeding efforts to improve yield per hectare and fibre quality properties have proved successful. Hybrid breeding has also proved successful as many hybrids have been released by breeders and cultivated by farmers. Hybrid vigour has manifested and have been harnessed in many crops including cotton (Kalhoro _et al_ 2015). This manifestation according to Baloch et al (1993), is predicated on the genetic diversity of parental lines. However, early generation hybrids are known to express greater level of heterosis over later generations of a cross. Thus, selection at F_1 has proved not to be beneficial. As selection changes the genetic structure of a population (Budak _et al_., 2004), positive cotton improvement by selection at F_1 will largely depend on available genetic variability and superior genotypes resulting from the recombination of superior alleles at different loci. Data information on genotypic and phenotypic variability is of great importance in making effective selection and in further breeding programs (Isong and Balu, 2017). Genetic analysis of quantitative traits further helps to elucidate the nature and magnitude of genetic variation present in the F_1 population. In later generations, a considerable depression as a consequence of inbreeding is predicted. The extent of this depression in the same crop varies from character to character, generation to generation and also upon the types of hybrids. This decrease in fitness and vigour is due to fixation of unfavouable recessive genes in segregating generations. Magadum _et al_. (2012) opined that the relative amount of heritable variation could be assessed by heritability. This is vital as it also provides the basis for effective selection. Genetic variability along with heritability of a character will indicate the possibility and extent to which improvement is feasible through selection on phenotypic basis. Combination of heritability with genetic advance is more effective and reliable in predicting the resultant effect of selection (Ramanjinappa _et al_., 2011; Patil _et al_., 1996). Genetic Advance according to Hamdi _et al_. (2003) will likely show the magnitude of the expected genetic gain from one cycle of selection. This investigation sought to analyse the genetic

and phenotypic variability existing in the four selected inter-varietal hybrids, assess the heterotic components over parents and inbreeding depression on the F_2 generation.

Materials and Methods

The experiment was conducted on the research field of the Department of Cotton, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore during summer 2017. Four selected promising inter-varietal hybrids (TCH1716 x TCB37, TCH1705-101 x TCB209, KC2 x TCB26 and TSH0250 x DB3) from a line-tester cross, evaluated along with their F_2 generation, the eight parents and a standard hybrid check ((DCH32). The genetic materials were planted out in a Randomized Block Design (RCB) with three replications. Two rows each for parents and hybrids were planted at a spacing of 90 cm between rows and 60cm between plants. Basic agronomic procedures were observed. Observations from five randomly selected plants in each entry and in each replication for the traits *viz*., seed cotton yield (SCYPP) (g), plant height (PH) (cm), number of bolls per plant (NBPP), number of sympodial branches per plant (NSPP), number of monopodia branches per plant (NMPP), boll weight (BW) (g), number of seeds per boll (NSPB), ginning percentage (GP), lint index (LI) and seed index (SI) were recorded. Samples of seed cotton obtained were pooled, ginned and the lint obtained was evaluated for fibre quality characters *viz*; 2.5% span length (2.5%SL) (mm), fibre fineness (FF), bundle strength (BS), elongation percentage (EP) and uniformity ratio (UR) using High Volume Instrument 900 classic. Days to flowering (DF), days to 50 per cent flowering (DFF) and days to first bursting (DFB) were also observed for each entry per replication.AGRISTAT statistical analyses software was employed to analyze for various properties. Heterosis was estimated over mid parent (Relative), better parent (Heteobeltiosis) and the standard hybrid check (Standard heterosis). Test of significance was according to Turner (1953). Percentage of inbreeding depression according to Rao and Murthy (1970) was obtained. Heritability in the broad and narrow sense, genetic advance, phenotypic and genotypic coefficient of variation were all worked out

Results and Discussion

One of the characteristics of heterosis is that the increased vigour is confined only to F_1 generation. All the crosses exhibited significant mid parent and better parent heterosis for number of bolls per plant and seed cotton yield. The highest heterotic expression for seed cotton yield over standard check was 9.03% exhibited by TCH1705-101 x TCB209 (Cross II). The results of heterosis is in agreement with the report of Baloch *et al* .(1993). Their report indicated that exploitation of heterosis for number of bolls per plant and seed cotton yield per plant will be higher than for other traits. KC2 x TCB26 exhibited least (18.06%) inbreeding depression for seed cotton yield. Most recessive alleles for seed cotton yield per plant accumulated in KC2 x TCB26 which expressed maximum negative degree of dominance. This infers that heterosis breeding can be exploited for seed cotton yield per plant in F_1 generation in crosses TCH1716 x TCB37, TCH1705-101 x TCB209 and TSH0250 x DB3. Heterosis breeding procedures are effective in harnessing dominance gene action to the full extent (Mahalingam *et al.,* 2011).To express higher yield in KC2 x TCB26, further backcross to parent 1 (KC2) and subsequent selection in later generation would be of advantage. All the yield parameters recorded moderate to high PCV and GCV indicating an inherent and sufficient variability. However, earlier work by Ganesan and Raveendran (2007) also showed a higher PCV and GCV values for seed cotton yield. The PCV values were found to be higher than GCV in all the characters studied indicating a consistent environmental influence on these traits. This result is in agreement with the findings of Sakthi *et al*. (2007) and Tomar *et al*. (1992). This heritability range also confirms the report of Liu, *et al*., (2010) in interspecific hybrids. The implication for these on the characters is that the additive genetic variance has been fixed during breeding. The highest values for genetic advance were by TCH1716 x TCB37, TCH1705-101 x TCB209 and TSH0250 x DB3 for number of sympodial branches per plant. Genetic advance values are of minimal use in guiding the selection process in an early generation population like the interspecific F_1 hybrids. This is because most of the alleles for quantitative characters are heterozygous. More so, the phenotype expression is subject to influence of additive and dominant gene effects, and epistasis is assumed to be absent.

Table 1: **Genotypic and Phenotypic Parameters for yield and fibre quality traits**

Traits	Hybrids	MP	BP	SC	ID (%)	H^2	h^2	GA (%)	PCV(%)	GCV (%)
DF	I	-1.94	-6.48	7.45	3.81**	57.14	50.58	9.16	25.58	4.32
	II	-12.15	-19.66	0.00	-1.30**	25.45	10.85	3.66	25.43	3.35
	III	-6.34	-7.69	2.13	1.14**	73.41	46.26	0.73	26.36	2.60
	IV	-1.94	-6.48	7.45	-1.12	35.21	33.73	0.76	25.96	1.77
DFF	I	-7.05	-13.18	-0.88	-0.09	18.29	17.31	0.27	19.56	0.59
	II	-4.20	-10.94	0.88	0.52	95.53	47.15	1.95	19.22	4.23
	III	-14.06	-24.14	-2.65	-2.75**	53.35	44.74	1.63	19.29	2.84
	IV	-7.00	-11.02	0.00	-3.65*	65.26	41.63	1.97	18.87	3.44
DFB	I	-0.54	-3.17	1.67	-1.95	37.05	34.36	1.22	15.09	1.55
	II	0.00	-3.68	1.67	2.95**	75.54	48.77	2.34	15.09	3.56
	III	-1.89	-5.70	1.11	2.03	16.23	1.05	1.98	15.12	1.52
	IV	5.85	0.56	0.56	2.93**	69.52	68.48	1.31	15.16	2.18
BW	I	-7.19	-17.56	16.63	42.83**	95.18	46.26	0.15	95.60	36.36
	II	-9.71	-17.70	-1.64	17.18*	99.42	18.54	2.26	13.12	11.60
	III	11.99	8.28	34.29	-2.24	90.62	43.21	1.93	96.23	32.56
	IV	-21.04	-24.13	-6.37	17.59*	84.15	34.57	1.55	96.22	22.66
NBPP	I	105.94**	66.10**	43.92**	51.71**	97.78	24.87	4.85	92.95	43.75
	II	38.06**	25.88**	-4.75	26.25**	74.89	43.55	3.64	93.43	27.11
	III	36.13**	23.48**	20.18*	-5.25	90.83	31.23	1.61	92.34	23.44
	IV	56.18**	28.11**	6.82	25.17**	96.32	48.37	2.30	91.32	24.69
PH	I	34.19**	24.88	10.13	0.42**	79.61	26.66	49.54	48.83	27.29
	II	17.84	-0.66	1.43	24.55**	77.86	16.73	30.68	55.27	25.59
	III	33.64*	32.58*	-0.42	13.62	34.78	19.32	11.13	56.79	10.04
	IV	21.65	20.41	-0.42	37.43*	95.37	35.26	40.24	46.59	30.35
NSPP	I	28.4**	25.00*	13.64	23.18*	70.81	58.66	87.04	34.29	30.32
	II	16.72	12.12	-1.07	15.46	50.19	23.99	51.11	25.81	19.69
	III	23.94*	15.03	-5.88	25.20*	37.03	35.24	90.79	24.58	14.60
	IV	-2.17	-3.07	-15.51	6.09	48.23	47.89	91.79	24.29	24.04
NMPP	I	31.43**	4.55	15.00	34.06**	93.54	50.55	5.28	89.95	25.29
	II	18.75	11.76	-5.00	28.29**	57.61	20.00	5.31	90.19	15.27
	III	10.14	-2.56	-5.00	44.14**	90.45	23.03	7.87	90.44	26.87
	IV	87.88**	63.16**	55.00**	17.43**	52.37	11.59	6.49	90.32	16.44
SCYPP	I	38.87**	12.63**	3.75	61.37**	97.84	40.42	74.61	61.19	48.37
	II	55.32**	44.31**	9.03**	52.98**	91.26	30.93	62.19	74.10	40.88
	III	78.08**	68.26**	4.83	18.06	59.00	19.25	45.51	70.63	27.68
	IV	31.71**	25.72**	-1.68	59.69**	95.31	27.18	55.10	67.69	45.66
SI	I	36.28**	29.56**	32.99**	15.05	32.42	9.70	1.19	90.68	6.86
	II	0.81	-5.57	1.50	25.86**	81.48	29.63	2.55	93.30	16.24
	III	39.77**	33.09**	23.13*	17.06**	53.41	52.20	1.37	90.85	9.73
	IV	21.49*	5.35	23.27*	16.33	67.68	29.62	3.05	90.55	16.73
LI	I	9.96	5.77	19.78	1.61	40.92	34.01	20.25	58.24	8.12
	II	-9.11	-10.61	-14.04	16.38*	19.32	8.33	13.64	54.72	8.06
	III	29.56*	19.93	9.41	7.25	34.69	26.85	25.44	50.72	5.30
	IV	1.07	-6.92	5.10	0.95	18.55	9.92	19.03	51.41	6.39
NSPB	I	-7.69	-3.49	1.38	43.48**	95.45	25.14	71.08	23.32	32.57
	II	-16.37	-17.72	-16.57	22.41	35.07	32.57	57.62	23.93	12.28
	III	13.89	8.37	14.21	2.29	28.11	9.71	25.75	23.66	9.09
	IV	-29.82*	-31.74*	-28.95*	15.50*	39.33	37.62	45.74	22.89	12.72
GP	I	-16.93*	-20.47**	-10.73	14.49	45.23	28.28	1.72	91.71	9.81
	II	-4.05	-6.12	-15.17	12.45*	40.64	19.29	1.40	92.1	8.17
	III	-2.22	-13.81	-12.53	9.20	38.03	23.42	1.63	90.67	8.50
	IV	-16.12*	-22.94**	-14.22	0.091	20.54	18.69	1.92	94.34	6.73

Table 1: **Genotypic and Phenotypic Parameters for yield and fibre quality traits (Cont'd)**

2.5% SL	I	17.76	7.29	4.25	13.88	32.71	21.16	11.29	28.84	7.07
	II	21.50	10.22	0.85	3.86	20.63	17.48	5.12	28.57	3.74
	III	11.48	-2.86	-3.68	2.51	4.08	3.87	7.99	29.98	1.52
	IV	8.68	3.71	2.83	19.98	69.77	8.04	14.30	28.68	11.51
UR	I	1.74	-5.85	1.08	6.45*	42.21	37.19	1.09	90.45	5.66
	II	-2.14	-4.94	4.11	-1.19	57.24	48.45	1.85	88.56	8.77
	III	-17.8	-19.96	-4.55	1.69	35.27	34.02	1.13	89.63	5.68
	IV	4.08	1.07	2.16	-1.39	48.97	16.27	1.61	90.32	7.44
BS	I	5.28	-0.77	-1.15	5.20	43.06	41.85	20.68	47.38	7.97
	II	0.39	-1.54	-2.67	14.91	62.15	8.41	3.73	51.01	7.38
	III	18.04	13.25	1.15	6.83*	48.49	46.61	3.24	51.95	5.62
	IV	5.93	0.81	-4.58	8.37*	80.04	32.16	7.21	51.05	11.31
E%	I	-3.08	-17.11	1.61	17.73**	18.07	14.27	16.83	71.69	9.86
	II	6.45	-8.33	6.45	21.12**	57.12	30.46	10.38	72.69	13.86
	III	8.93	-6.15	-1.61	-5.36	15.09	13.85	8.22	70.05	5.66
	IV	16.67	5.00	1.61	4.82	51.45	41.18	9.29	71.83	12.28
FF	I	-4.23	-12.82	-10.53	-13.21*	63.81	46.41	9.23	72.84	14.79
	II	-25.00**	-28.57**	-21.05	5.35	29.61	15.47	6.45	75.00	8.38
	III	-18.68*	-28.85**	-2.63	1.57	63.75	53.77	12.54	81.75	16.51
	IV	-15.07	-18.42	-18.42	10.35	18.98	8.74	7.59	74.25	7.16

Conclusion

In conclusion, hybridization and effective selection for all the characters in these populations will be effective because of the availability of high variability in the characters. The hybrids can further be evaluated for their stability and be released for commercial cultivation in view of their heterotic and inbreeding performance.

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Evaluation of National Cereals Research Institute (NCRI) Castor Germplasm for Identification of Potential Resistant Genotypes to *Cercospora* Leaf Spot

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Abstract
Evaluation of castor germplasm of the National Cereals Research Institute, Baddegi for resistant genotypes to Cercospora leaf spot was carried out under natural field conditions. The genotypes were grown on a resolvable incomplete block design with three replications. The results obtained revealed high variability of host resistance among the genotypes. Percentage disease incidence ranged between 16.67% and 100%. A range between 1.43 score and 4.17 score with average score of 2.89 were recorded for disease severity among the genotypes. Highest (95.92%) and lowest (13.03%) damage index were observed in the genotypes Acc. 059 and Acc.022, respectively. The results reported here could serve as a basis for further screening of the potential genotypes under controlled condition to develop resistant lines.
Keywords: Disease, castor, incidence, cercospora, and Badeggi

Introduction
Castor (*Ricinus communis* L.) is a non-edible oil crop with many industrial applications. It is widely cultivated in the tropics, subtropics and warm regions for its seed from which oil is extracted (Purseglove, 1968; Weiss, 1971). Castor plant suffers from many diseases caused by fungi and bacteria. There are many causal pathogens known to cause infections in castor. Some of these pathogens are seed-borne. Fungal diseases cause a lot of economic damage in castor, and in some areas, it is a limiting factor to commercial castor cultivation (Anjani *et al*., 2004). The fungal disease incidence often appears in castor farms and if not managed, can cause severe economic loss to the farmers. Some fungal diseases commonly found in castor include leaf spot caused by *Cercospora ricinella,* wilt caused by *Fusarium oxysporum* f *spricini*, root rot caused by *Macrophomina phaseolina*, gray rot caused by *Botrytis ricini*, Alternaria and leaf spot caused by *Alternaria ricini* (Anjani*et al*., 2004; Duke, 1983). In the present study, on-field observation of fungal infection caused by *Cercospora ricinella* in castor was carried out in an effort to identify potential resistant genotypes in the castor germplasm evaluated.

Methodology
On-field observations on fungal leaf spot disease caused by *Cercospora ricinella* were made on 86 castor genotypes at the National Cereals Research Institute (NCRI), Badeggi. The genotypes were grown on a resolvable incomplete block design with three replications. The plot size was 3m by 1.5m with inter-row and intra-row spacing of 75 cm. Two seeds per hole were planted and later thinned to one seedling per hole at three to four weeks after planting. NPK 15:15:15 fertilizers were applied at one month after planting and weeding was done three times during the experiment as at when due. Disease incidence was determined by counting diseased leaves and expressed as percentage of total leaves. Disease severity was carried out by scoring diseased plants using a 1 – 5 scales as described by Mamza (2008). Damage index (DI) was determined according to Manandhar *et al.* (2016). Data were taken on individual plants in each plot at first spike flowering and maturity. The scoring and estimation of damage index was done as follows;
Score scale for the leaf spot:

1	=	All leaves without symptom
2	=	1 – 25% of total leaf number with symptoms
3	=	26 – 50% of total leaf number with symptoms

4 = 51 – 75% of total leaf number with symptoms
5 = 76% and above of total leaf number with symptoms

Damage index (DI) = (Incidence X Severity) / Highest severity

Results and Discussion

Average mean values for disease incidence, disease severity and damage index are presented in Table 1. Disease incidence varied between 16.67% (Acc. 017) and 100% (Acc. 059), with average of 65.91%. A range between 1.43 score (Acc. 022) and 4.17 score (Acc.056 and Acc. 094), and average of 2.89 score were recorded for disease severity among the genotypes. Highest (95.92%) and lowest (13.03%) damage index was observed in Acc. 059 and Acc.022, respectively. The results obtained revealed high variability of host resistance among the genotypes. This may be an indication of presence of different gene recombinants for the leaf spot resistance among the genotypes from which resistant lines could be developed. In this sense, genotypes with low damage index will be good sources of resistance genes. The values obtained here are similar to the result of Mamza *et al.* (2008) who reported fungal leaf blight incidence and severity on castor seedling at different stages. Yield loss of 80% to 100% has been attributed to fungal disease in India (Mamza *et al.*, 2008). Lakshmi *et al.* (2010) reported that damage to castor leaves caused reduction in seed yield and any 1m^2 loss of leaf area resulted in 37.83g and 24.4g seed yield and seed oil yield respectively per hectare.

Conclusion

Identifying sources of fungal disease resistance genes is an important breeding objective in any castor improvement programme. Severe yield reduction in castor has been attributed to fungal leaf blight. The results reported here could serve as basis for further screening of the potential genotypes under controlled condition to develop resistant lines for breeding programme.

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Table 1: Mean values of disease incidence, severity and damage index of 86 castor genotypes at NCRI Badeggi

S/N	Genotypes	Incidence	Severity	DI
1	Acc.001	44.33	2.33	24.77
2	Acc.002	39.00	1.83	17.12
3	Acc.003	75.00	3.67	66.01
4	Acc.004	64.33	1.93	29.77
5	Acc.005	74.67	1.67	29.90
6	Acc.006	60.33	2.77	40.08
7	Acc.007	51.67	2.67	33.08
8	Acc.008	67.00	2.77	44.51
9	Acc.009	61.00	2.93	42.86
10	Acc.010	70.67	2.77	46.94
11	Acc.012	53.67	2.77	35.65
12	Acc.015	71.33	3.10	53.03
13	Acc.016	75.00	3.33	59.89
14	Acc.017	16.67	2.15	8.60
15	Acc.018	50.67	2.43	29.53
16	Acc.019	42.00	2.30	23.17
17	Acc.022	38.00	1.43	13.03
18	Acc.024	58.00	2.60	36.16
19	Acc.026	37.33	2.00	17.90
20	Acc.027	43.67	2.00	20.95
21	Acc.028	80.00	2.77	53.14
22	Acc.029	39.00	2.27	21.23
23	Acc.031	57.00	3.50	47.84
24	Acc.032	59.67	3.00	42.93
25	Acc.033	72.33	2.67	46.31
26	Acc.034	71.00	3.00	51.08
27	Acc.035	39.00	2.50	23.38
28	Acc.036M1	64.00	2.27	34.84
29	Acc.036	67.00	3.00	48.20
30	Acc.039	71.33	2.67	45.67
31	Acc.040	77.00	3.33	61.49
32	Acc.041	53.67	2.67	34.36
33	Acc.042	89.00	2.33	49.73
34	Acc.043	87.00	3.33	69.48
35	Acc.044	71.33	2.17	37.12
36	Acc.045	56.00	2.50	33.57
37	Acc.046	40.67	2.50	24.38
38	Acc.047	85.00	2.43	49.53
39	Acc.048	38.67	1.83	16.97
40	Acc.050	77.67	3.17	59.04
41	Acc.051	82.00	2.30	45.23
42	Acc.052	74.67	3.43	61.42
43	Acc.053	61.75	2.88	42.65
44	Acc.054	43.67	3.33	34.87
45	Acc.055	79.00	3.00	56.84
46	Acc.056	86.67	4.17	86.67
47	Acc.057	80.60	2.92	56.44
48	Acc.058	74.67	3.17	56.76
49	Acc.059	100.00	4.00	95.92
50	Acc.060	73.33	2.27	39.92

Table 1: Mean values of disease incidence, severity and damage index of 86 castor genotypes at NCRI Badeggi (cont'd)

S/N	Genotypes	Incidence	Severity	DI
51	Acc.061	38.6	1.93	17.90
52	Acc.062	63.33	3.10	47.08
53	Acc.063	89.00	3.00	64.03
54	Acc.064	70.00	2.83	47.51
55	Acc.065	75.67	3.60	65.33
56	Acc.066	58.67	2.77	38.97
57	Acc.067	65.00	3.50	54.56
58	Acc.068	71.00	3.60	61.30
59	Acc.069	79.67	3.10	59.23
60	Acc.070	54.33	3.17	41.30
61	Acc.071	70.33	2.77	46.72
62	Acc.072	51.67	2.50	30.98
63	Acc.073	67.33	3.17	51.18
64	Acc.075	78.33	3.83	71.94
65	Acc.076	66.50	2.50	39.87
66	Acc.077	61.67	2.43	35.94
67	Acc.080	96.00	4.10	94.39
68	Acc.081	92.67	4.00	88.89
69	Acc.083	68.00	3.67	59.85
70	Acc.085	80.00	2.00	38.37
71	Acc.087	59.00	2.93	41.46
72	Acc.088	74.00	3.43	60.87
73	Acc.089	43.00	3.60	37.12
74	Acc.090	75.50	3.58	64.82
75	Acc.091	58.67	2.83	39.82
76	Acc.093	70.00	3.00	50.36
77	Acc.094	87.00	4.17	87.00
78	Acc.095	92.67	3.60	80.00
79	Acc.096	83.67	3.50	70.23
80	Acc.097	67.33	3.43	55.38
81	Acc.098	64.33	3.27	50.45
82	Acc.099	61.67	2.17	32.09
83	Acc.100	69.67	3.27	54.63
84	Acc.101	67.00	3.50	56.24
85	Acc.102	60.33	2.17	31.40
86	Acc.103	48.00	2.50	28.78
	Mean	65.91	2.89	46.46
	LSD	7.31	0.43	3.68

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Variability Studies among Some Okra (*Abelmoschus esculentus* L. Moench.) Accessions from Niger State, Nigeria

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Abstract
Field experiment was carried out at Canchaga, Badeggi, Niger State, to reveal the variability among some okra accessions. Thirty one accessions of okra were collected from farmers field and two (LD-88 and Nhae-47) collected from the Department of Crop Production of the Federal University of Technology Minna. The accessions were planted on Randomized Complete Block Design (RCBD) and replicated three times. Each accession was planted on 2m x 1.5m plot. The experiment was carried out during dry and raining (2014/2015) season. Data were collected on twenty morpho-agronomic traits. Results of the principal component analysis of the combined seasons for the traits studied showed that the first five principal components accounted for 77.2 % and 89.0 % of the total variations in the population. Single Linkage Cluster Analysis (SLCA) clustered the accessions in accordance to their similarity level through the aid of dendrogram. SLCA of the combined season showed two major cluster groups that were linked at 65.7% level of similarity. Accessions that showed variability and clustered in different group may be useful for improvement of okra.

Introduction
Okra is a member of the family *Malvaceae* and genus *Abelmoschus*. Okra has a prominent position among fruit vegetables due to its multiple virtues like high nutritive and medicinal value, ease of cultivation, wide adaptability, year round cultivation, good portability, export potential and bountiful returns (Reddy *et al.,* 2012). It is a multipurpose crop due to the numerous uses of the fresh leaves, buds, flowers, pods and stems, dry stems, pods and seeds (Schippers, 2000; Siemonsma and Kouame, 2004). Nigeria is the second largest producer of okra in the world (1,978,286 tonnes) followed by Sudan and Mali (FAOSTAT, 2016). However, yield in Nigeria is 2.86 tha^{-1} compared with 24.70, 20.60, 13.20, 9.98, and 3.58 tha^{-1} in Senegal, Ghana, Egypt, Kenya and Benin Republic respectively (FAOSTAT, 2013). A total of 2,283 okra accessions had been reported world-wide (Anonymous, 2010). A total of 77.49% of the okra accessions are currently found in West Africa (Oppong-Sekyere *et al*., 2012). Udoh *et al.* (2005) reported that Okra varieties vary in plant height, size of fruit, colour, early or late maturing, long pod, lady finger, dwarf green pods. Abdelmageed *et al.* (2012) also reported variability in characters such as yield, plant height, pod length, pod diameter, pod colour and number of days to flowering of okra. Measuring of genetic diversity and determining the variation between accessions help ensure germplasm is efficiently collected and managed. The success of a breeding programme depends on the measure of the degree of genetic divergence and genetic diversity which is a key factor for crop improvement (Reddy *et al*., 2012). Plant breeders can use genetic similarity information to complement phenotypic information in the development of breeding populations (Yuzbasıoglu *et al.,*2006). Variation is an important attribute in breeding programmes (Omonhinmin and Osawaru 2005). Gana *et al.* (2013) reported that the success of a crop improvement programmes are highly reliant on the efficient manipulation of genetic variability. The yield of okra obtained per unit area in Nigeria is very low which need to be improved upon and revealing the variability among the diverse accessions will aid the breeders evolve new genotypes that will be high yielding, disease and pest resistant. Therefore this study was conducted to collect, evaluate and reveal the variation that exists among some okra accessions.

Materials and Methods

Fruits of 31 accessions of okra were collected from Bosso, Paiko, Shiroro, Bida, Lavun, Mashegu, Katchia and Mokwa Local Government Areas of Niger state, Nigeria. NHe-47-1 and LD-88-1 Okra varieties were obtained from the Department of Crop Production, Federal University of Technology Minna, Nigeria. Field evaluation study was conducted in two growing seasons: under irrigation in 2014 dry season and 2015 raining season respectively at Chanchaga village (N 09^0 04' 14.0, E 006^0 05' 26.9, Elevation: 103 m), Badeggi, Niger State Nigeria. The 33 accessions were grown in a randomized complete block design (RCBD). Each accession was grown on a 2 m x 1.5 m plot and replicated three times. Each row was 2 m long with inter row distance of 75 cm. The spacing between plants along a row was 50 cm (i.e 75 cm x 50 cm spacing) giving five stands per row. The plants were thinned to two per stand at two weeks after seed sowing.NPK 15:15:15 fertilizer was applied at the rate of 200 kg per hectare after three weeks of planting. The experimental field was weeded manually (using hoe) twice at 3 and 8 weeks after sowing (WAS). Five plants were selected from each row for data collection on leaf colour, leave shape, fruit shape, position of fruits on main stem, fruit hairiness and petiole colour. A standard crop descriptor for okra (IBPGR, 1991) was used to characterise the various parameters. The data collected were used for Principal Component Analysis (PCA) and Cluster analysis to determine genetic variation and percentage similarities using Statistical Tool for Agricultural Research (STAR, 2013).

Results and Discussion

Combined Seasons Principal Component Analysis of Quantitative traits

The result of the combined analysis presented in Table 1 revealed that PC1 accounted for 25.7% while PC 2 contributed 18.2% of the total variation. The only character that made negative contribution to variation in PC1 was 100-SW (-0.07). The characters that contributed most to the observed 25.7% variation in PC 1 included fruit girth (0.444), stem diameter (0.402), number of nodes (0.328) and number of seeds per fruit (0.329). The 18.2% variation observed in PC 2 was largely influenced by days to first flower appearance (-0.474), days to 50% flowering, fruits per plant (0.351) and fruit weight per plant (0.428). PC 3 with 14.2% contribution was largely influenced by fruits per plant (0.558) and moderately influenced by fruit weight per plant (0.374) and petiole length (-0.358).

Table 1: Eigen value, vector scores and contribution of the first five axes to variation in okra accessions of the combined seasons

Parameter	PC1	PC2	PC3	PC4	PC5
Plant height	0.226	0.107	-0.279	0.379	-0.254
Petiole lrnthg	0.283	0.265	-0.358	0.284	0.271
Stem diameter	0.402	0.144	-0.081	0.093	0.396
Nrumber of nodes	0.328	-0.141	0.372	-0.146	-0.031
Days to first flower appearance	0.29	-0.474	0.198	0.076	-0.107
Days to 50% flowering	0.28	-0.497	0.098	0.13	-0.111
Fruits per plant	0.116	0.351	0.558	0.079	-0.115
Fruit length	0.02	0.288	0.005	0.026	-0.536
FRUITR	0.257	0.013	-0.339	-0.495	-0.137
Fruit girth	0.444	-0.038	-0.034	-0.133	0.238
Fruit weight per plot	0.215	0.428	0.374	-0.119	0.131
Number of seeds per fruit	0.329	0.125	-0.174	-0.185	-0.516
100 Seed weight	-0.077	0.013	-0.059	-0.637	0.145
Eigen value	3.3388	2.366	1.8402	1.3993	1.086
Percentage	25.7	18.2	14.2	10.8	8.4
Cumulative	25.7	43.9	58	68.8	77.2

Principal Component Analysis of Qualitative Traits of Studied Okra Accession

The first five principal components accounted for 89.0% of the total variations in this population. However, only PC 1 and PC 2 with eigen values $\geq$1 had significant contribution to the observed variation. Both PC 1 and PC 2 have cumulative variation of 55.0 with PC 1 contributing 33.9% and PC 2 contributing 21.1%. Leaf colour (0.50) and petiole colour (0.52) had the most effects on the 55.0% variation. All other traits measured had moderate effects except fruit shape (0.18) and fruit position (0.28). Only fruit shape (0.61) and leaf shape (-0.41) had major effect on the contribution from PC 2 to total variation.

Table 2: Eigen value, vector scores and contribution of the first five axes to variation in okra accessions of the combined seasons for qualitative characters

Parameter	PC1	PC2	PC3	PC4	PC5
Leave colour	-0.503	-0.327	0.153	-0.065	0.183
Stem colour	-0.387	0.176	-0.337	-0.689	-0.207
Fruit shape	-0.183	0.614	-0.292	-0.061	0.5
Fruit Position	-0.279	0.368	0.672	0.123	0.305
Fruit hairiness	-0.329	-0.328	-0.499	0.46	0.38
Petiole colour	-0.523	-0.273	0.243	-0.09	-0.214
Leave shape	0.323	-0.41	0.136	-0.532	0.624
Eigen value	2.372	1.477	0.944	0.782	0.654
Percentage	33.9	21.1	13.5	11.2	9
Cumulative	33.9	55	68.5	79.6	89

Cluster Analysis of Qualitative traits of Okra Accessions Studied

Cluster analysis of the results of qualitative traits studied using complete linkage method revealed two major cluster groups (Figure 1). All accessions fell into three groups. Accessions 16 and 31 belonged to one group, Accessions 6 and 30 belonged to the second group, while the rest of the Accessions belonged to the third group. The three groups were linked at 65.7% level of similarity. The largest group was further divided into different sub groups depending on their level of similarities. Accessions 1 and 28, 13 and 27, 14 and 19, 12 and 13 showed close similarity levels.

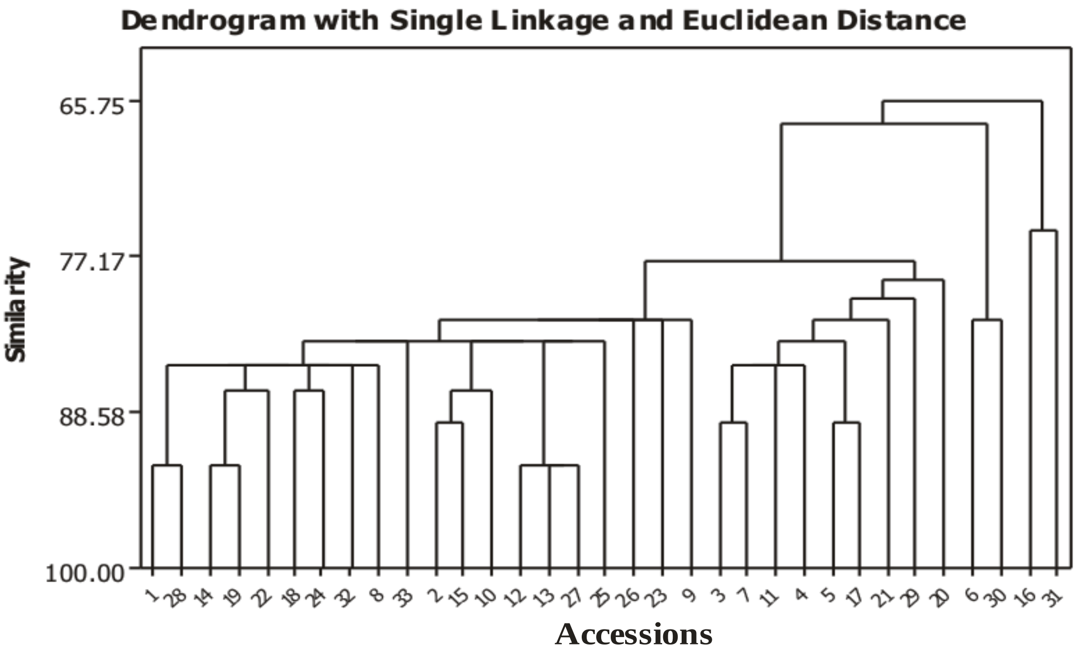

Figure 1: Dendrogram of the 33 Okra accessions based on qualitative traits

Note that: Bata-01= 1, Bata-02= 02, Dama-01= 03, Dama= 04, Egwa-01= 05, Egwa-02= 06, Esungi= 07, Gbadebo-01= 08, Gbadebo-02= 09, Gbadebo-03= 10, Gbadebo-04= 11, G-mayi= 12, Jazu= 13, K-Gar-01=14, K-Gar-02=15, K-Gar-03=16, Kwati= 17, LD-88= 18, NHae-47= 19, Pati-01= 20, Pati-02= 21, Pati-03= 22, Pati-04= 23, Pati-05= 24, Pati-06= 25, Shaba-01= 26, Shaba-02= 27, S-Lambu= 28, S-Rami= 29, Tafita= 30, Tafita sss= 31, T-Daga-01= 32, T-Daga-02= 33.

The Qualitative parameters in this study had revealed variations among the accessions. Variability was noted in all the traits among the accessions studied. This result is in conformity with the result of a study conducted in Ghana by Amoatcy *et al*. (2015) which showed significant difference in vegetative and reproductive traits of some okra cultivars which the authors stated that the phenotypic variation observed within the qualitative traits corresponded to the diverse collection sites. Oppong-Sekyere *et al.* (2011) also noted that the genetic affinity between accessions from different regions could be attributed to selection and exchange of germplasm between farmers and ethnic groups. The principal component analysis revealed the percentage contribution made by each character studied to the total variation in the population. Result of this work has revealed that different traits contributed differently to the total variation in the population which conform with the result obtained from the study carried out by Nwanburuka *et al.* (2011), using PCA to study variation among 29 okra accessions at Abeokuta, Nigeria. Characters that had high variability are expected to provide high level of gene transfer during breeding programmes as stated by Gana (2006). Maga *et al*. (2014), reported that traits which associated with PC1 and PC2 are implicated for being responsible for the phenotypic divergence observed in the studied cultivars and can be used for cultivar discrimination. The dendrogram obtained from Single Linkage Cluster Analysis (SLCA) of this study showed the accessions in accordance to their similarity percentage levels which revealed that the accessions differed. Nwanburuka *et al.* (2011) reported that dendrogram drawn from SLCA showed the relationship accessions and stated that SLCA provided information on the minimum percentage similarity among accessions and also provided an overall pattern of variations as well as degree of relatedness among accessions. However the accessions used in this study might have originated from parents with diverse genetic background since their genetic similarity index is lower than 95%, because it has been documented that for any two or more accessions to be taken as genetically identical, their genetic similarity index (GSI) should be equal to or greater than 95% (Anderson, 2007).

Conclusion

Variations existed among the okra accessions used in this studied. PCA and SLCA revealed contributions and distinctiveness of traits among the accessions. Existence of variations in the population revealed that the genotypes had different genetic make-up which can be utilize for okra improvement. The dendrogram showed distinctiveness and relatedness among the accessions depending on their characteristics. Accessions that cluster in different groups with higher variability (lower similarity percentage) should be used for okra improvements.

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Genetic variability and correlation of stalk yield-related traits and sugar concentration of stalk juice in a sweet sorghum (*Sorghum bicolor* L. Moench) population

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Abstract
The productivity of sweet sorghum (Sorghum bicolor L. Moench), a raw material for ethanol production, is mainly determined by stalk yield and sugar content. To understand inherent differences and relationship between stalk yield related traits and sugar concentration of stalk juice, a population derived from a grain sorghum × sweet sorghum was screened to select parental materials which were crossed and the F_1 hybrids evaluated in Institute for Agricultural Research (IAR) Samaru, Ahmadu Bello University Zaria irrigation field during the 2017 dry season. The experiment was laid out in a randomized, 4 x 8 alpha lattice design with two replications. Seven stalk yields and sugar related traits including days to flowering, plant height, number of internodes, 1000-grain weight, panicle length, brix content and sugar concentration of stalk juice were evaluated. Significant differences among genotypes were observed for all measured traits. Both the magnitude and direction of correlation coefficients among the traits measured were varied in different trials. Direct selection for brix content was shown to be more important than indirect selection, while selection for stem biomass had no effect on stem brix. Information obtained from this study will be very helpful to further understand the genetic mechanism of stalk yield related traits and sugar concentration of stalk juice in this population.
Keywords: Correlation, Genetic variability, Sorghum bicolor L. Moench, Stalk yield related traits, Sugar concentration and Sweet sorghum

Introduction
Sweet sorghum, a specific type of *Sorghum bicolor*, has been considered a potentially valuable source for biofuel production because of its high energy convertion efficiency (Reddy *et al.*, 2005). Many characteristics such as green stalk yield, stalk sugar content, stalk juice extractability and grain yield have been proved as major contributors to its economic superiority (Almodares *et al*., 2008). However, these traits are quantitatively and polygenically inherited in nature and very difficult to be manipulated directly in breeding procedure. Therefore, to successfully improve these complex traits, they need to be dissected into smaller morphological, physiological and genetical components, which are easily analyzed and evaluated. Cultivar development is, however, firstly based on the exploitation of genetic variability of the genotypes with the traits of interest (Makanda *et al.,* 2009). Therefore, establishing the genotypic variability available for stalk yield associated traits and sugar concentration of stalk juice in a sorghum population is very important in determining the feasibility of developing elite sweet sorghum varieties. The consequences of the phenotypic variation depend largely on the environment. This variation is further complicated by the fact that all genotypes do not respond to environmental changes in similar ways, and no two environments are exactly the same. Furthermore, correlations between the traits are of great importance for success in selections to be conducted in breeding programs. Significantly positive correlations indicate that the changes in two variables are in the same direction, while negative correlations indicate their inverse relationships with each other. For example, stalk yield has significantly positive correlations with plant height, stem diameter and juiciness (Audilakshmi *et al.*, 2010). Therefore, the improvement

of stalk yield should focus on both plant height and stem diameter. Total sugar content could be calculated from the Brix because of a significant linear correlation between Brix and total sugar content of the juice (Ma *et al*., 1992). The genetic variability and correlation of bio-fuel related traits have been studied in several different populations (Srinivas *et al.,* 2009; Shiringani *et al.*, 2010). In order to study the genetic mechanisms of stalk yield related traits and sugar concentration of stalk juice, a specific population has been developed from a cross between grain and sweet sorghum lines in our breeding nursery. The objectives of this study, therefore, were: (1) to evaluate the variability of the population for stalk yield related traits and sugar concentration of stalk juice; (2) to assess the strength of associations between stalk yield related traits and sugar concentration of stalk juice.

Materials and Methods

The experiment was conducted at the Institute for Agricultural Research (IAR) farm, Ahmadu Bello University, (ABU) Zaria (Latitude $11^0$11'N and $7^0$38'E), situated in the Northern Guinea Savannah Zone in Nigeria. The research was carried out in 2017/2018 under irrigation. Genetic materials consisted 32 genotypes (10 parents that comprised of grain and sweet sorghum, 21 F_1s and 1 check) which were laid out in a randomized, 4 x 8 alpha lattice design with two replications and evaluated at IAR research field, Samaru for agronomic traits and sugar contents. Each experimental unit consisted of two- rows plot of 3 m with inter – and intra row spacing of 30 cm x 75 cm. The data collected was subjected to analysis of variance using General Linear Model procedure of Statistical Analysis System (SAS) package (SAS, 2002), while significant difference between treatments means were determined using the Least Significant difference (LSD) test. The correlation coefficients were estimated using the formula described by Singh and Chaudhary (1985).

Results and Discussion

The mean squares from the analysis of variance (Table 1) showed highly significant ($P \le 0.01$) differences among the genotypes for all the characters studied. The presence of variability in measured traits suggests improvement can be made through selection. The plant height ranged from 135.70 cm for F5.3ssm10-14/2-1 to 244.9 cm for Samsorg 14 with a mean height of 185.1 cm among the parents (Table 2). Hybrids Samsorg 44 x F5.3ssm10-31/2-3 (269.8 cm), Samsorg 44 x F5.3ssm10-1/3-3 (269.1 cm) and Samsorg 44 x F5.3ssm10-1/1-8 (267.2 cm) were among the tallest. The hybrid Samsorg 14 x F5.3ssm10-31/5-1 (42.8 cm) recorded the highest panicle length followed by Samsorg 14 (36.3 cm). High brix greater than the mean was observed in Samsorg 40 x F5.3ssm10-1/1-8 (8.4 %), Samsorg 40 x F5.3ssm10-31/2-3 (8.2 %) and Samsorg 14 x IESV92028DL (8.2 %) genotypes. Genotype Samsorg 44 x F5.3ssm10-31/2-3 (15.04 g/l) gave the highest sugar yield followed by Samsorg 40 x F5.3ssm10-1/3-3 (13.8 g/l), Samsorg 14 x F5.3ssm10-31/5-1 (13.2 g/l) and Samsorg 40 x F5.3ssm10-31/5-1 (13.2 g/l), while genotype Samsorg 14 x F5.3ssm10-1/1-8 (5.6 g/l) had the lowest sugar yield followed by F5.3ssm10-31/2-3 (1.5 g/l) and F5.3ssm10-1/1-8 (2.4 g/l). Plants with greater plant height, brix content and juice yield also produced greater sugar yields. Higher mean values for time to flowering and plant height indicated that good options exist for selecting the genotypes with different maturity levels that can be suitable for cultivation in the dry savannah ecologies with marginal rainfall. Days to flowering exhibited significant and positive correlation among the hybrids for plant height (0.78) and number of internodes (0.80). Among the parents, days to flowering showed significant and positive correlation with plant height (0.68) and number of internodes (0.95). The positive correlation coefficients between plant height and days to flowering suggests that plant height increases as days to flowering increases, which is consistent with earlier reports in sorghum by Alam *et al*. (2001). Among the hybrids, number of internodes exhibited significant and positive correlation with days to flowering (0.80) and plant height (0.73) while among the parents number of internodes showed significant and positive correlation for days to flowering (0.95) and plant height (0.81). Brix content showed significant positive correlation with 1000- grain weight (0.99) but showed negative significant correlation with days to flowering (-0.48), plant height (-0.44), number of internodes (-0.61) and panicle length (-0.71). The correlation study has demonstrated important relationships between brix content and other agronomic traits association in sweet sorghum.

Conclusion

With the results of the present research work, there is a good scope for selection for days to 50% flowering, plant height, panicle length and brix content to improve these characters. Also, with the observed strong associations between days to flowering, plant height, number of internodes and sugar related traits, these characters could be used as the most reliable selection criteria to improve brix content in sorghum.

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Table 1: Mean squares of analysis of variance for sugar content and some agronomic characters among 32 sorghum genotypes evaluated at Samaru in 2017

Sources of Variation	Degree of freedom	Days to 50% flowering	Plant Height (cm)	Number of Internodes	Panicle Length (cm)	1000-Grain Weight (g)	Brix content(%)	Sugar Concentration (g/L)
Rep	1	123.77	346.89	2.44	0.46	2.14	0.57	0.05
Block	3	6.44	205.16	5.26	22.84	3.71	0.91	15.03
Rep(Block)	3	74.80	80.62	2.06	19.15	0.39	0.09	2.84
Entry	31	1629.02**	3798.84**	20.27**	54.90**	15.24**	3.81**	24.02*
Error	25	44.52	86.83	2.00	17.44	5.60	1.40	16.57

** Highly Significant and * Significant at 0.01% and 0.05% levels of probability, respectively

Table 2: Mean performance of 32 sorghum genotypes for sugar content and some agronomic characters evaluated at Samaru in 2017

Genotype	Days to 50% flowering	Plant Height (cm)	Number of Internodes	Panicle Length (cm)	1000-Grain Weight (g)	Brix content (%)	Sugar Concentration (g/L)
Parents							
Female (Grain Sorghum)							
Samsorg 14 (P1)	163.1	244.9	15.7	36.3	12.3	6.3	6.7
Samsorg 40 (P2)	101.1	167.9	8.3	20.8	14.5	7.4	6.3
Samsorg 44 (P3)	150.9	160.3	11.2	31.3	11.4	5.9	2.4
Male (Sweet Sorghum)							
F5.3ssm10-8/2-2 (P4)	91.4	187.2	8.3	29.9	13.3	6.8	1.5
F5.3ssm10-1/1-8 (P5)	163.8	243.9	15.1	30.2	10.8	5.6	7.1
F5.3ssm10-14/2-1 (P6)	94.6	135.7	8.6	19.9	12.8	6.5	4.8
IESV92028DL (P7)	104.9	151.3	7.3	18.6	15.8	8.0	8.6
F5.3ssm10-31/2-3 (P8)	93.3	189.2	7.4	23.1	7.8	4.0	10.9
F5.3ssm10-1/3-3 (P9)	160.6	202.2	13.9	30.6	12.7	6.5	7.6
F5.3ssm10-31/5-1 (P10)	91.2	168.5	7.8	19.2	15.4	7.9	4.2
Mean	121.5	185.1	10.4	26.0	12.7	6.5	6.0
Range	91.2 - 163.8	135.7 - 244.9	7.3 - 15.7	18.6 - 36.3	7.8 - 15.8	4.0 - 7.9	1.5 - 10.9
F_1 Hybrids							
Samsorg 14 xF5.3ssm10-8/2-2	161.4	200.5	16.0	23.6	13.7	7.0	7.2
Samsorg 14 x F5.3ssm10-1/1-8	181.8	256.8	12.8	19.4	11.3	5.8	5.6
Samsorg 14 x F5.3ssm10-14/2-1	109.6	204.5	7.6	27.9	12.7	6.5	6.3
Samsorg 14 x IESV92028DL	112.5	246.6	9.1	27.2	16.0	8.2	6.9
Samsorg 14 x F5.3ssm10-31/2-3	138.6	265.0	9.1	17.9	14.3	7.3	11.3
Samsorg 14 x F5.3ssm10-1/3-3	171.8	259.4	14.7	34.2	11.9	6.1	10.7
Samsorg 14 x F5.3ssm10-31/5-1	165.6	249.9	15.3	42.8	4.7	2.5	13.2
Samsorg 40 x F5.3ssm10-8/2-2	98.6	159.3	7.3	18.6	15.9	8.1	10.5
Samsorg 40 x F5.3ssm10-1/1-8	95.9	206.1	10.2	24.3	16.6	8.4	12.5
Samsorg 40 x F5.3ssm10-14/2-1	97.9	148.9	8.5	24.6	12.9	6.6	6.6
Samsorg 40 x IESV92028DL	94.8	161.9	8.3	23.0	14.1	7.2	10.3
Samsorg 40 x F5.3ssm10-31/2-3	80.1	137.7	5.7	20.8	16.1	8.2	11.4
Samsorg 40 x F5.3ssm10-1/3-3	106.9	200.8	9.0	26.6	12.2	6.2	13.8
Samsorg 40 x F5.3ssm10-31/5-1	86.3	150.8	9.6	24.1	11.5	5.9	12.7
Samsorg 44 x F5.3ssm10-8/2-2	154.6	263.8	15.9	30.4	13.0	6.7	8.6
Samsorg 44 x F5.3ssm10-1/1-8	124.2	267.2	14.8	29.2	8.2	4.3	5.8
Samsorg 44 x F5.3ssm10-14/2-1	124.4	207.2	10.2	29.0	9.9	5.1	8.1
Samsorg 44 x IESV92028DL	112.8	196.0	8.1	29.6	11.9	6.1	7.2
Samsorg 44 x F5.3ssm10-31/2-3	156.1	269.8	16.4	28.1	7.7	4.0	15.0
Samsorg 44 x F5.3ssm10-1/3-3	143.0	269.1	16.4	30.7	11.3	5.8	12.3
Samsorg 44 x F5.3ssm10-31/5-1	128.1	230.0	14.1	31.9	6.8	3.5	6.5
Samsorg 38 (Check)	93.8	150.3	9.3	23.2	12.6	6.4	9.2
Mean	124.5	213.7	11.3	26.7	12.1	6.2	9.6
Range	80.1 - 181.8	137.7 – 269.8	5.7 - 16.4	17.9 - 42.8	4.7 - 16.6	2.5 - 8.4	5.6 - 15.0
%CV	5.4	4.6	12.9	15.8	19.3	18.8	50.3
LSD	13.7	19.2	2.9	8.6	4.9	2.4	8.4

Table 3: Correlation coefficients of 10 characters of hybrid (upper diagonal) and parent (lower diagonal) sorghum genotypes evaluated at Samaru during the 2017 dry season

Correlation	Days to 50% flowering	Plant Height (cm)	Number of Internodes	Panicle Length (cm)	1000-Grain Weight (g)	Brix content (%)	Sugar Concentration (g/L)
Grain yield (kg/ha)	-0.21	-0.29	-0.12	-0.14	0.42	0.43	0.33
Days to 50% flowering		0.78**	0.80**	0.39	-0.48*	-0.48*	-0.07
Plant Height (cm)	0.68*		0.73**	0.43	-0.44*	-0.44*	-0.01
Number of Internodes	0.95**	0.81**		0.55*	-0.61**	-0.61**	0.07
Panicle Length (cm)	0.79**	0.75*	0.83**		-0.70**	-0.71**	0.09
Panicle Exertion	-0.52	-0.18	-0.40	-0.49	0.22	0.21	-0.20
Panicle Weight (g)	0.02	-0.43	-0.06	-0.23	0.63**	0.63**	0.33
1000-Grain Weight (g)	-0.27	-0.40	-0.27	-0.40		0.99**	-0.04
Brix content (%)	-0.26	-0.39	-0.27	-0.40	0.99**		-0.04
Sugar Concentration (g/L)	0.07	0.24	0.05	-0.21	-0.34	-0.35	

** Highly Significant and * Significant at 0.01% and 0.05% levels of probability, respectively

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AMMI Stability Analysis for Root Yield Traits of Cassava Genotypes in Nigeria

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Abstract

The additive main effects and multiplicative interaction (AMMI) model was used to analyse the fresh root yield and root dry matter content of twenty cassava genotypes grown in three locations in 2015 and 2016 cropping season (a total of six environments) in Nigeria. Main effects due to environments (E) and genotypes (G) were found to be significant (P<0.05) for root dry matter content (RDMC) and highly significant (P<0.01) for fresh root yield (FRY). Genotype by environment interaction and IPCA1 were highly significant (P<0.001) for FRY and RDMC. This study has identified Igbariam location to be most stable for high root yield and dry matter content. The study has identified stable high yielding genotypes with high dry matter content such as IBA131825, IBA131746, IBA131872, IBA131767 and IBA131770, suggesting it is possible to combine these traits in cassava as desired by farmers. However, these genotypes can be tested further in more environments to ascertain their specific adaptability for release to farmers for cultivation to boost cassava production and ensure food security.

Introduction

Cassava is a starchy root crop which is widely grown in many parts of sub – sahara Africa, with Nigeria being the highest producer (FAO, 2014). More than 50% of Nigeria's population eats cassava at least once in a day (Njoku *et al.*, 2014) and it serves as famine reserve crop in the country. Root yield losses in unfavourable environments can be as high as 80% when compared to root yield in optimum environments. This is because genotypes exhibit different levels of phenotypic expression under different environmental conditions. Genotype by environment interaction results from differences in the sensitivities of genotypes to the conditions in the target environment (Farshadar, 2013), leading to inconsistent performances of genotypes across environments. This limits the efficiency of selection of superior genotypes. The efficiency and success of genotypic selection depend on the consistency of performances of genotypes in varying environments (Yan *et al*., 2000). For this reason, genotypes are tested in diverse environments to assess their adaptability and stability on the yield performance. It is often difficult to determine the stability pattern of genotypic responses across environments without the use of appropriate multivariate analytical and statistical tools such as additive main effects and multiplicative interactions (AMMI). The AMMI model integrates analysis of variance (ANOVA) and principal component analysis (PCA) into a unified approach that can be used to analyze multi-locational trials (Crossa *et al*., 1990; Gauch and Zobel, 1996). The study was carried out to determine the stability of root yield traits of selected advanced cassava genotypes evaluated across many environments.

Materials and Methods

The study was conducted in 2015 and 2016 at three sites: Umudike (annual rainfall of 2200 mm; altitude 120 m; mean annual temperature of 22 to 31^{o}C; coordinates 7^{o}24'E, 5^{o}29' N; DystricLuvisol soils; humid forest); Igbariam (annual rainfall of 1800 mm; altitude 150 m; mean annual temperature of 24 to 32^{o}C; coordinates 7^{o}31' E, 5^{o}56' N; DystricLuvisol soils; forest–savanna transition); and Otobi (annual rainfall of 1500 mm; altitude 319 m; mean annual temperature of 24 to 35°C; coordinates 7°20' E, 8°41' N; Ferric Luvisol soils; southern Guinea savanna) in Nigeria. These sites represent the major cassava-growing agro-ecological zones in the country. Twenty cassava genotypes tolerant to cassava green mite were used in the study. The trial was laid out in a randomized complete block design with three replications. Each plot consisted of 10 plants per row on ridges. Spacing between ridges was 1m and also between plants within the row providing a total population of 10 000 plants ha^{-1}. NPK 15:15:15 fertilizer was applied at the rate of 600kg/ha. Fertilizer was applied at eight weeks after planting using the ring method. Weeding was done by hoe. Data were collected on fresh root yield (FRY) and root dry matter content (RDMC) at harvest. Eight innermost plants per clone were uprooted and used for phenotypic assessments. Estimation of RDMC (measured as a percentage) in the root samples were determined by the specific gravity method as suggested by Kawano *et al*., (1987).

$$Specific\ gravity = \frac{Weight\ in\ water\ (g)}{Weight\ in\ air\ (g) - Weight\ in\ water\ (g)}$$

$DMC\ = 158.3\ specific\ gravity - \ 142.0$ (IITA, 1990)

Data analysis

Data were analyzed using Genstat version 12.1 and R statistical software package. The additive main effect and multiplicative interaction (AMMI) analysis was performed using the model suggested by Farshadfar *et al*. (2011) as follows:

$$Y_{ij} = \mu + G_i + E_j + \sum_{k=1}^{n} \lambda_k \alpha_{ik} \gamma_{jk} + e_{ij}$$

where Yij is the yield of the ith genotype in the jth environment, μ is the grand mean, Gi is the ith genotypic effect, Ej is the jth environment effect, λk is the square root of the eigenvalue of the PCA axis k, αik and γjk are the principal component scores for PCA axis k of the ith genotype and the jth environment, respectively, and eij is the residual.

The AMMI stability value (ASV) as described by Purchase *et al*. (2000) was calculated as follows:

$$ASV = \sqrt{\left[\frac{IPCA1_{Sum\ of\ squares}}{IPCA2_{Sum\ of\ squares}}(IPCA1_{score})\right]^2 + (IPCA2_{score})^2}$$

where IPCA1Sum of squares/IPCA2Sum of squares is the weight given to the IPCA1-value by dividing the IPCA1 sum of squares (from the AMMI analysis of variance table) by the IPCA2 sum of squares. The larger the IPCA score is, either negative or positive, the more adapted a genotype is to a certain environment.

Results and Discussion

The combined AMMI analysis of variance revealed that there were significant genotypic variations for all the traits indicating opportunity for selection and prospects for the improvement of cassava for the traits. The AMMI ANOVA indicated significant ($P < 0.05$) effects of environment and genotype for RDMC. Genotype by environment interaction and IPCA1 were highly significant ($P < 0.001$) for RDMC (Table 1). The influence of genotype by environment interaction (80.00%) on RDMC was greater than both genotype (18.16%) and environment effects (1.84%). The first two IPCAs (IPCA1 and IPCA2) contributed 33.59% and 27.15% of the interaction sum of squares respectively (Table1). Genotype by environment interaction, genotype effect and IPCA1 were very highly significant ($P < 0.001$) for FRY. Effect of environment for FRY was highly significant ($P < 0.01$) for FRY (Table 1).Genotype by environment interaction effect (76.45%) contributed a greater proportion of the treatment sum of squares compared with genotype effect (18.09%) and environment effect (5.46%). The first two principal component axes (IPCA1 and IPCA2) accounted for 30.79% and 21.79% of the interaction sum of squares respectively (Table 1). The impact of environment was highly significant for FRY and RDMC, justifying the need for multilocational testing to identify good performers for specific locations. IPCA1 was significant for all the traits studied and it explained the interaction pattern better than

IPCA2. The percentage of the treatment sum of squares (SS) captured by an AMMI ANOVA in this study is useful for assessing the overall goodness of fit. There were significant responses of genotype by interaction for all the traits. This implies different adaptation by the different genotypes suggesting the need to identify and select location specific genotypes for different environments. Stability analysis methods are often used by breeders to identify genotypes that have stable performance and respond positively to improvements in environmental conditions (Farshadfar *et al*., 2012). For RDMC, AMMI stability analysis identifies these genotypes IBA131753, IBA131743, IBA131729, IBA131738 and IBA131849 as the superior genotypes (Table 2). Genotype IBA131743 showed a wide adaptability since it was found in the six of the tested environments (Table 2). The superior genotypes IBA131825, IBA131746, IBA131872, IBA131741 and IBA131770 were selected as combining high FRY with stability (Table 3). Two genotypes IBA131870 and IBA131767 were widely adapted to three environments for FRY; the former was found in the high and moderately high yielding environments, and the latter was seen in high, moderately high and low yielding environments. This suggests that IBA131767 was insensitive to seasonal effects and can be recommended for production in the environments. IBA131825 and IBA131865 were adapted to the two most stable environment (Igbariam2015 and Igbariam2016). This indicates that the genotypes were better able to exploit their full potential yield in the good environments.

Conclusion

The study has identified stable high yielding genotypes such as IBA131825, IBA131746, IBA131872, IBA131767 and IBA131770, suggesting it is possible to combine these traits in cassava as desired by farmers. These genotypes can be evaluated in more environments to assess their adaptability and possible recommendation for release to farmers for cultivation.

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Table 1: Summary of AMMI analysis for root dry matter content and fresh root yield of 20 cassava genotypes grown in six environments (three locations x two years) in Nigeria

		RDMC					FRY				
Source	**df**	**SS**	**MS**	**F**	**%TSS**	**%GEI SS**	**SS**	**MS**	**F**	**%TSS**	**%GEI SS**
Total	1115	45748	41.03				386139	346.3			
Treatments	371	17965	48.42	1.33***			139401	375.7	1.15***		
Genotypes	61	3263	53.49	1.47*	18.16		25218	413.4	1.26***	18.09	
Environment	5	331	66.12	0.67^{ns}	1.84		7610	1522	2.51*	5.46	
Block	12	1187	98.91	2.72*			7267	605.6	1.85***		
GEI	305	14372	47.12	1.30***	80		106573	349.4	1.07***	76.45	
IPCA1	65	4827	74.25	2.04***		33.59	32812	504.8	1.54***		30.79
IPCA2	63	3902	61.94	1.70*		27.15	23226	368.7	1.13^{ns}		21.79
Error	732	26596	36.33				239471	327.1			

Table 2: First four AMMI selections based on genotypes with best high dry matter content in each environment

Rank	**Environment**	**Mean**	**Effect**	**1**	**2**	**3**	**4**
1	Igbariam2016	28.93	5.80	IBA131743	IBA131849	IBA131754	IBA131784
2	Umudike2016	28.02	-1.40	IBA131753	IBA131776	IBA131743	IBA131849
3	Otobi2016	27.57	-4.40	IBA131762	IBA131734	IBA131743	IBA131849
4	Igbariam2015	28.12	5.21	IBA131858	IBA131768	IBA131743	IBA131836
5	Umudike2015	26.27	0.66	IBA131743	IBA131768	IBA131856	IBA131869
6	Otobi2015	25.76	-5.87	IBA131743	IBA131748	IBA131800	IBA131777

Table 3: First four AMMI selections based on genotypes with best root yielding in each environment

Rank	**Environment**	**Mean**	**Effect**	**1**	**2**	**3**	**4**
1	Igbariam2015	30.04	-7.40	IBA131825	IBA131767	IBA131856	IBA131870
2	Igbariam2016	29.98	-8.16	IBA131825	IBA131767	IBA131856	IBA131870
3	Umudike2016	22.35	6.46	IBA131872	IBA131870	IBA131743	IBA131851
4	Otobi2015	21.40	8.18	IBA131754	IBA131752	IBA131750	IBA131774
5	Umudike2015	14.49	1.69	IBA131782	IBA131770	IBA131872	IBA131833
6	Otobi2016	12.62	-0.78	IBA131844	IBA131767	IBA131734	IBA131812

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Morphological Description of Polynesian Arrowroot (*Tacca leontopetaloides* (L.) Kuntze) from Benue State Nigeria

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Abstract
Polynesian Arrowroot (Tacca leontopetaloides (L.) Kuntze) is a wild growing acaulescent herb whose tubers are consumed by some ethnic nationalities in the north central Nigeria. The starch from the tubers has been found to be of industrial quality. This paper describes the morphological features of this plant based on a collection grown at Umudike (latitude 05° 29' N, longitude 07°33' E) from tubers collected from Zaki-biam LGA of Benue State. The features of the plant and variation in its characters based on visual observations were documented. Implications of the observed variations on domestication Polynesian arrowroot in Nigeria are discussed.
Keywords: Leaves, Stolon, Rhizome, Fruits, Floral structures, and Domestication

Introduction
Polynesian Arrowroot (*Tacca leontopetaloides* (L.) Kuntze) is popularly known as Amora, or Gbache by some ethnic nationalities in Nigeria. It belongs to the genus Tacca and family Taccaceae (IPNI, 2005). However some taxonomists group it with the yam family Dioscoreaceae (Caddick *et al*. 2002). It is distributed throughout Asia to Australia and Africa (Drenth, 1972). It is an annual monocot. The above ground parts die down every year and re-grow the next season from underground tubers when they break dormancy. Polynesian Arrowroot is an autonomous self-pollinating species (Zhang *et al*, 2007, 2011) with diploid (2n = 30) number of chromosomes (Darlington and Wylie, 1955). Tubers contain b-sitosterol, ceryl ethanol, and a bitter substance taccalin (Caddick *et al*., 2002; Scheuer *et al*, 1963). The rhizome of has medicinal virtues of detoxification, diminishes inflammation and acesodyne, can cure abscesses of the stomach and duodenum, high blood pressure, hepatitis, gastralgia, scalds, burns, tumefaction, and ulcers (Zhang *et al*., 2007). Abdel *et al*, 1991 found extracts from Polynesian arrowroot to have very good anticancer properties
In Nigeria, these plants grow in the wild as in other parts of Africa but are virtually unutilized with an annual production estimated at over 20 million MT (Omolaja, 2013). Polynesian Arrowroot is found naturally growing in the tropical rainforest and guinea savannah agroecologies of Nigeria. The plant is wider spread in the middle belt (Manek *et al*, 2005) and in the south western states (Borokini *et al*., 2014). Specifically, Pate *et al*, 2014 reports that it is found widely in Plateau and Nassarawa states. They have also been collected from the wild in Anyamelu LGA of Anambra State, The indigenous people of middle belt of Nigeria who consume the starch from the tubers of Polynesian arrowroot see this plant as a gift from God as it is always there in the wild for them to gather. They have therefore seen no need to domesticate it. In recent years, the population of the plant in the wild is dwindling probably due to increasing use of herbicides and urbanization. This coupled with the increasing recognition of the industrial quality of its starch (Kunle *et al*., 2003; Ukpabi, *et al*., 2009; Vu *et al*, 2017) have brought to the fore the need to domesticate the plant. National Root Crops Research Institute (NRCRI) Umudike and Raw Material Research and Development Council (RMRDC) Abuja are collaborating in the pilot effort to cultivate Polynesian arrowroot. An understanding of the morphology and morphological variations of this plant is needed for its domestication. This paper describes the morphological variation in Polynesian arrowroot with a view to highlighting its features the knowledge of which in necessary in order to harness its potentials and encourage its domestication

Materials and Methods

Ten thousand tubers of Polynesian arrowroot of various sizes were collected from Zaki-biam LGA of Benue State in October 2017 were used to plant a hectare at Umudike in 2018 in a collaborative project between NRCRI Umudike and RMRDC, Abuja (Fig 1D). The variation in the morphology of the Polynesian arrowroot plants grown on this one hectare plot based on visual observation is presented. Striking features were captured in Camera.

Results and Discussion

Morphology and Variation

Stem

Polynesian arrowroot is acaulescent. The stem is an underground tuber with apical and auxiliary buds

Leaves

Leaves extend from the apex of the underground tuber. 2-7 leaves per plant were observed. The leaves have longitudinally ribbed long hollow petioles of variable lengths which extend from the underground apex of the tuber and bear large trifid leaflets at their apex. The leaflets are pinnately lobed. The base of the petioles are sheathed while the lamina of leaflets are reticulately veined (Fig 1B).

Floral structures

Hollow Peduncles (0-2 per plant) of varying length with sheathing base arise from the underground tubers. There is usually one peduncle per plant but plants having no peduncles and a few with two peduncles were observed. Based on their length three type of peduncles were observed. Short Type: Peduncles at or shorter than the foliage usually with drooping tip; Medium type: Peduncles erect, slightly above the foliage; and Long type: Peduncles erect, very much longer than the foliage. Peduncles subtend at their apex an umbellate inflorescence bearing many flowers (10-50) subtended by several green to purple whiskers-like filiform bracteoles (almost as many as the flowers) about 10-14 cm long and greenish two whorled bracts. The bracts of the outer whorl are larger than the inner bracts (Fig 1A). Anthers are attached to a hood-like structure which brings them very close to the stigma. This floral structure is in tandem with their autonomous self pollination habit. The Stigma is 3-lobed with each lobe divided into two.

Fruits

Fruits are many (1-20), ovoid, ribbed, with persistent tepals at the apex (Fig 1C). They are subtended by short pedicels 3-5cm in length. The fruit - a berry develops from an inferior unilocular ovary with parietal placentation. They are green when immature but turn yellow when matured.

Seeds

Each fruit contains numerous striated brownish seeds with various shapes such as spherical, ovate, obovate, and elliptical (Fig 1E). Seeds are dormant at harvest.

Stolon

Stolons develop from the base of the apex of the mother tuber and grow vertically downwards swelling at the tip to form the tuber (Fig 2G-H). The stolon is cylindrical, stout, 5-15cm in length and takes the tubers deeper into the soil below the mother tuber and probably away from pests. 1-4 stolons were observed per plant but only one often ends up in fully formed tubers.

Tubers

The tubers are shperical and somewhat flattened at the apex (Fig 2 F-K). They have cream coloured skin and white flesh colour. Most plants produced only one tuber but a few produced two to four tubers. A plant with 9 tubers (1 big, 2 small, and 6 tiny tubers) was observed (Fig 2J). Tubers weighed mostly between 200-600g each but a few weighed up to 900g. Tubers are dormant at harvest.

Roots

The main roots are adventitious ranging from 20-50 depending on the size of the mother tubers. They arise from the base of the apex of the tuber and grow to lengths ranging from 10-25cm. There are roots on the surface of developing tubers (Fig 2K).

Implications of the morphology for Domestication

The floral structures become established before the foliage suggesting that plant places a premium on the production of sexual seeds over the production of tubers. Since most of the early resources mobilized from the mother tuber goes to establish the floral structures at the detriment of the foliage, removing the floral structures as soon as they emerge above ground may lead to more robust foliage that will result in production of more assimilate which if channelled to tubers will result in higher yield.

Most plants produce only one tuber per plant. Considering that tuber is the economic part of the plant and at the same time the main means of propagation, 1:1 multiplication ratio poses a major limitation to domestication. However few plants were found to produce multiple tubers suggesting the existence of variability upon which selection can be imposed to improve on the number of tubers. In addition, multiple stolon produced by a good number of plants indicate that the plant has the potential to produce more than one tuber under favourable condition

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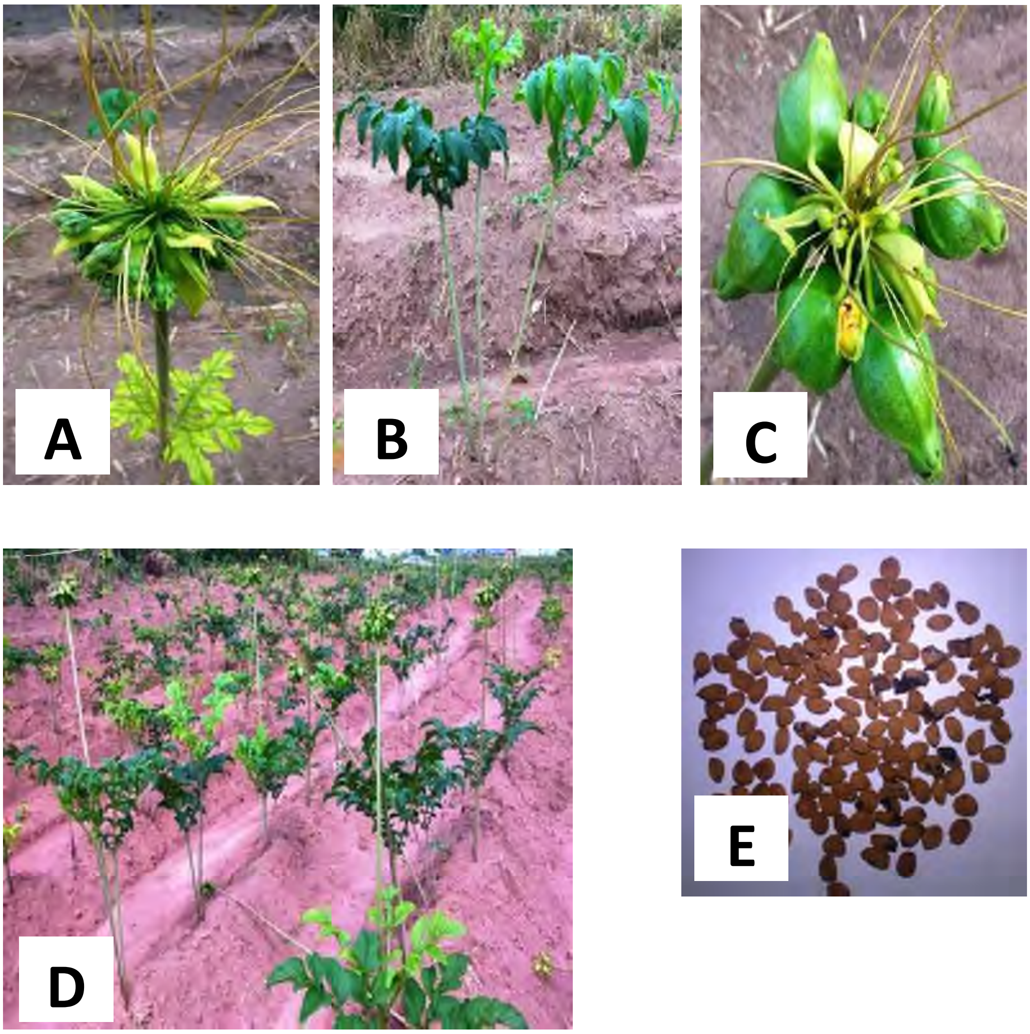

Fig 1:Polynesian Arrowroot above ground structures (A) Umbellate Inflorescence, (B) Trifid leaves (C) Fruits (D) Field growing plants (E) Seeds

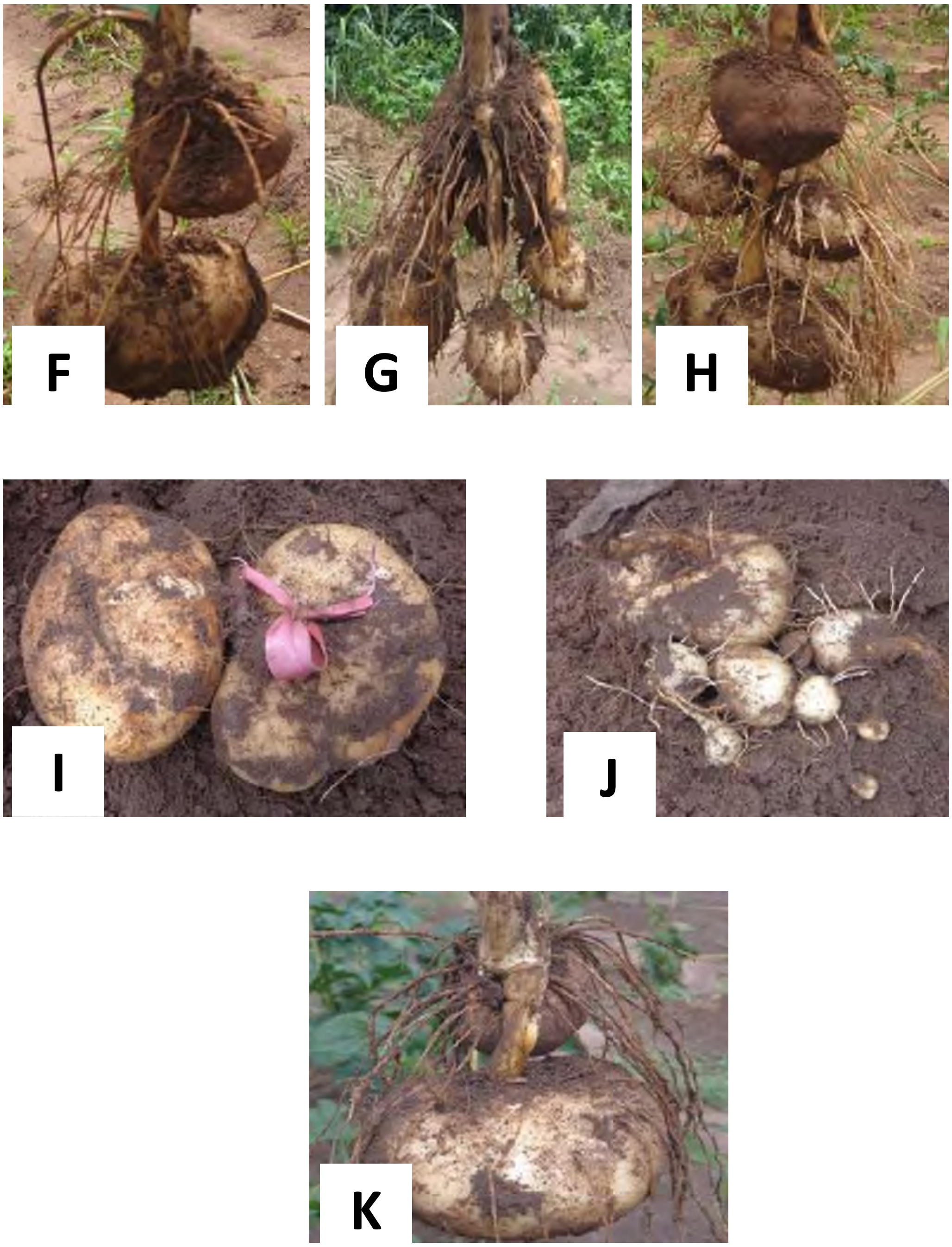

Fig 2: Underground Parts of Polynesian Arrowroot (F-J) Plants with single and multiple tubers (K) Roots from apex of the mother tuber and body of developing tubers.

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Morphological and Nutritional Differences between Male and Female Plants of Fluted Pumpkin (*Telfairia occidentalis* Hook. f.)

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Abstract
A field experiment was conducted in 2016 at the National Root Crops Research Institute Farm, Umudike, Southeastern Nigeria, to investigate the morphological and nutritional differences between male and female individuals of fluted pumpkin (Telfairia occidentalis Hook. f.). Female plants had significantly higher (p<0.05) stem diameter, petiole length, petiole diameter, tendril diameter, harvestable vegetable weight, edible vegetable weight, and 10 leaf weight, than male plants. They also had leaves with significantly higher moisture and iron content (p<0.05) than male plants. Crude fibre content was higher (p<0.05) in leaves of male plants than in leaves of female plants. There was no significant difference between males and females in the fat, crude protein, ash and carbohydrate contents of their leaves.
Keywords: Fluted pumpkin, dioecious, male plants and female plants

Introduction
Fluted pumpkin (*Telfairia occidentalis* Hook. f.), a herbaceous perennial climber usually cultivated as an annual, belongs to the Cucurbitaceae family of dicotyledonous plants and originated from tropical West Africa (Schippers, 2000). Although a perennial by nature, it is usually grown as an annual (Ogbonna, 2009). It is prized for its leaves and seeds, which constitute an important component of the diet in many Nigerian homes (Ayanwale and Abiola, 2007; Odiaka *et al*, 2008). Fluted pumpkin is a dioecious species, and the sex of any given individual plant cannot be ascertained until flower appearance, which takes about 13 weeks for the male, and 16 for the female. The inability to determine the sex of an individual plant before flowering is a challenge to farmers who would handle the two sexes differently, to maximize profits. The objectives of the present study were to: i) study the morphological differences between male and female individuals in *T. occidentalis* with respect to stem diameter, petiole length, petiole diameter, tendril diameter, harvestable vegetable weight, edible vegetable weight and 10 leaf weight, and ii) investigate differences in the nutritional contents of the leaves of male and female *T. occidentalis.*

Materials and Methods
The field experiment was conducted at the National Root Crops Research Institute, Umudike Research Farm. Umudike is located at latitude 05^{0}29'N and longitude 07^{0}32'E on an elevation of 100 meters above sea level. After the land had been ploughed and harrowed by use of a tractor, planting was done in 21 beds, each measuring 3m x 2m. The distance between beds was 1m. In each of the 21 beds, six (6) seeds were planted at a spacing of 1m inter-row and 1m intra-row, giving a total population of 126 (one hundred and twenty-six) plants, equivalent to 100,000 plants per hectare. Beds that had both male and female individuals were randomly sampled for a study of morphological and nutritional differences between the sexes. The experiment covered a total area of 270m^2. The fluted pumpkin seeds used were sourced from a local market at Ndoro in Ikwuano L.G.A of Abia State. The field was kept weed-free, through manual weeding, throughout the duration of the work. Data were collected on morphological and nutritional characters at flowering. The morphological characters were stem diameter, petiole length, petiole diameter,

tendril diameter, harvestable vegetable weight, edible vegetable weight, and weight of 10 leaves, while the nutritional characters included moisture, fat, crude protein, crude fibre, ash, carbohydrate and iron content of leaves. Stem diameter (mm) was obtained as the thickness of the stem taken above the tenth leaf from the base of the crop. The measurement was done using a pair of vernier sliding calipers. Petiole length (mm) was obtained as the length of the leaf stalk, from the leaf axis to the point where it is attached to the blade, using a ruler. Petiole diameter (mm) was obtained as the diameter of the petiole at the mid-point between the leaf axil and the base of the leaf, using a pair of vernier sliding callipers. Tendril diameter (mm) was obtained as the diameter of the tendril at the mid-point between the point where the tendril arises on the stem and the point where it develops the first branch, using a pair of vernier sliding calipers. Harvestable vegetable weight (g) was obtained as the weight of the vegetable harvest of each plant including the leaves and shoot, using a weighing scale. Edible vegetable weight (g) was obtained as the weight of edible portion of the harvestable vegetable weight, using a weighing scale. 10 leaf weight (g) was obtained as the weight of 10 leaves of each plant, using a sensitive balance. Moisture content was determined by the gravimetric method described by Bradley Jnr (2003). Fat content was determined by the continuous solvent extraction method using a soxhlex apparatus, as described by Min and Bott (2003). Protein content was determined by the Kjeldahl digestion method described by Chang (2003). Crude fibre content was determined by the method of Bemiller (2003). Ash content (%) was determined using the incineration method (AOAC, 2000). Carbohydrate content was calculated using the formula below as described by James (1995).

% Carbohydrate = 100 - % (protein + fat + fibre + ash + moisture content).
For any given parameter, sample means of the two sexes - males and females - were obtained and compared with each other by use of independent student's t- test.

Results and Discussion

Table 1 presents the mean values and t-test comparison in respect of the morphological and nutritional characters studied. Female plants had significantly higher stem diameter ($p<0.01$), petiole length ($p<0.05$), petiole diameter ($p<0.05$), tendril diameter ($p<0.01$), harvestable vegetable weight ($p<0.05$), edible vegetable weight ($p<0.01$), and 10 leaf weight ($p<0.01$) than male plants.

Table 1: Means and t-test comparison for some morphological and nutritional parameters in male and female individuals of fluted pumpkin

Parameter	Male	Female	t-test comparison
Stem diameter (mm)	5.6800	8.2000	0.001**
Petiole length (mm)	111.8200	130.5100	0.025*
Petiole diameter (mm)	4.2500	5.4460	0.001**
Tendril diameter (mm)	1.5380	2.0160	0.000**
Harvestable vegetable weight (g)	209.8800	522.8000	0.019*
Edible vegetable weight (g)	79.3500	239.0100	0.017*
10 leaf weight (g)	18.9800	39.5600	0.000**
Moisture content of leaves	8.0250	8.3280	0.011*
Fat content of leaves	0.6700	0.6880	0.746^{ns}
Crude protein content of leaves	10.0220	10.1470	0.866^{ns}
Crude fibre content of leaves	17.8940	15.5790	0.025*
Ash content of leaves	4.6120	4.5940	0.948^{ns}
Carbohydrate content of leaves	57.9990	60.3450	0.111^{ns}
Iron content of leaves	0.21670	0.33580	0.001**

Nb: ns – non-significant; * - significant at $p<0.05$; ** - significant at $p<0.01$

The leaves of female plants had significantly higher moisture ($p<0.05$) and iron ($p<0.01$) content than those of male plants. Crude fibre content was higher ($p<0.05$) in leaves of male plants than in leaves of female plants. There was no significant difference between the leaves of male plants and those of female plants with respect to their fat, crude protein, ash and carbohydrate contents.

The observation that female plantls had significantly higher stem diameter, petiole length, petiole diameter, tendril diameter, harvestable vegetable weight, edible vegetable weight, 10 leaf weight, and moisture content of roots than males, is in agreement with the finding of (Asiegbu, 1985) who reported that female plants are more vigorous than male plants and produce higher vegetative yields. It is also in line with the observations of local farmers, who are traditionally more protective of young plants (in the vegetative phase of development) that appear to be more vigorous than others, in the belief that the more vigorous plants have a higher probability of turning out to be females than those that are less vigorous. These local farmers are usually right. Larger morphological features, especially in respect of leaves and green stems, are expected to be associated with greater photosynthetic ability, which the female plants need in order to sustain their usually longer lifespan and reproductive functions, including fruiting. Also, thicker stems and tendrils offer additional strength to vines of female plants which need to be strong in order to carry the weight of pods that usually hang down on a climbing stem. In male plants, signs of senescence, including a drop in leaf yield, appear soon after anthesis.

Conclusion

The male and female plants of fluted pumpkin studied exhibited differences as well as similarities in respect of morphological and nutritional parameters. Male plants had significantly lower ($p<0.05$) stem diameter, petiole length, petiole diameter, tendril diameter, harvestable vegetable weight, edible vegetable weight, and 10 leaf weight, than female plants. The leaves of female plants had significantly higher ($p<0.05$) moisture content than those of male plants, but the sexes did not differ from each other with respect to the fat, crude protein, ash and carbohydrate composition of their leaves. Female plants had higher iron content in their leaves ($p<0.05$) than male plants.

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Morphological And Genetic Variation Of *Tilapia Guineensis* Populations From Nigerian Coastal Waters

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Abstract
Morphometric and molecular techniques were used to characterize and investigate genetic diversity of T. guineensis populations from some Nigerian coastal waters for breeding and conservation purposes. Results of morphometric analysis showed that T. guineensis populations can be differentiated into only two distinct groups. The results implied low variability among the populations of T. guineensis from the coastal locations studied. This implied that T. guineensis populations from Nigerian coastal waters are morphologically different. Iwoama and Brass (Bayelsa state) populations were the most varied among all the studied populations. Furthermore, When compared to other locations, fish in Iwoama and Brass had the highest mean weight of 0.29±0.006 kg and 0.27±0.004 kg with mean total length of 0.24±0.002 m and 0.23±0.001 m. Molecular studies showed that Buguma in Rivers state, Badagry in Lagos state and Brass in Bayelsa state populations had the highest genetic diversity as was revealed by heterozygosity and shannon indices. Clustering using SSR data gave four major clusters reflecting some level of genetic variability. Rivers, Lagos and Bayelsa states show greater genetic and morphological divergence and are therefore considered suitable areas for sourcing T. guineensis for fish improvement.
Key words: *Tilapia guineensis, morphometric, meristic, population variation, genetic diversity,*

Introduction
Tilapia guineensis (Bleeker, 1862), one of the dominant Tilapia species in Nigeria and other West African countries is a euryhaline species usually found in creeks, lagoons, and other coastal waters of West Africa (Philippart and Ruwet, 1982). It is one of the Cichlid species and an important source of animal protein and income throughout the world especially in developing countries like Nigeria with many rural populations relying on subsistent farming (Sosa *et al*., 2005). It has continued to contribute immensely to the nutritional needs, economic growth, and development of many nations including Nigeria.
The Nigerian coastal zone comprises of Lagos, Ondo, Delta, Rivers, Bayelsa, Akwa Ibom and Cross River states and parts of Edo state, and the majority of these populations depend on catch from the wild. This includes *T. guineensis* as a source of animal protein. Therefore, efforts to determine the current level of diversity and genetic structure of *T. guineensis* populations in Nigeria and many other parts of the world are useful for fishery management, aquaculture, stock conservation, and fish improvement through breeding.
The analysis of phenotypic variation in morphometric characters or meristic counts is the method most commonly used to delineate stocks of fish (Hockaday *et al*., 2000). The population genetic analysis of species in nature is of primary importance in developing an optimal strategy for their breeding, conservation and effective management. Proper investigation has revealed dearth of information on the knowledge of *Tilapia guineensis* in terms of genetic diversity of its natural populations using microsatellite markers. In view of the importance of genetic variability in selective breeding, there is therefore need to assess the genetic diversity of *T. guineensis* for its improvement.

Materials and Methods
Sample collection was carried out after a pre-survey study in twelve locations from six Nigerian coastal states (two locations per state) for *T. guineensis* species. The locations and the

coordinates of sampling stations are listed in Table 1. Specimen were obtained from fishermen at the landing site of every station and identified by a fish taxonomist from Marine Biology Department of Nigerian Institute for Oceanography and Marine research Lagos, Nigeria. Fifty (50) fish samples were randomly selected for morphometric analysis and ten specimen for molecular study from each location. During the field trip, collected samples (tissue) for molecular analysis were preserved in 90% ethanol inside eppendorff tubes to prevent genetic and molecular deterioration while fish samples for morphometric analysis were stored in ice chase in order to prevent morphological deformation (Allendorf, 1987).
A total of 13 morphometric variables were directly measured to the nearest 0.1 cm using a thread and measuring board. Measurements of body parts were made with the head of fish pointing left. However, to avoid possible biases produced by size effects on the morphometric variables, all morphometric characters were standardized by dividing the measurement by the standard length of each fish to minimize the effect of fish size (Allendorf *et al.*, 1987).

For molecular study, genomic DNA was extracted from the caudal fin tissue (1 cm^2) using phenol-chloroform method according to Sambrook and Russell (2001) protocol. The quality of extracted DNA was checked using a Nano-drop spectrophotometer. Nine microsatellite primers were utilized to characterize and investigate genetic variation. Polyacrylamide gel electrophoresis was used for the separation of the amplified DNA.

Statistical Analysis

Paleontological Statistics (PAST; Version 18) software package was used for the analysis of morphological data. In order to reduce variables to principal component that can explain most of the variation, principal component analysis (PCA) was carried out while Population genetic data generated was analyzed using PopGen version 3.6 software.

Table 1. Geographical location of Sampling Stations

Location	Latitude	Longitude	State
Buguma	N04^{o} 44.613^{1}	E006^{o} 57.401^{1}	Rivers
N. Calabar	N04^{o} 448^{1}	E07^{o} 010^{1}	Rivers
Ishaka	N05^{o} 03.243^{1}	E005^{o} 45.332^{1}	Delta
R. Ethiope	N05^{o} 53.397^{1}	E005^{o} 33.671^{1}	Delta
Epe	N06^{o} 35.832^{1}	E02^{o} 59.096^{1}	Lagos
Igbokoda	N06^{o} 21.028^{1}	E004^{o} 48.319^{1}	Ondo
Oropo	N06^{o} 25.238^{1}	E04^{o} 75.228^{1}	Ondo
Iwoama	N04^{o} 51.224^{1}	E06^{o} 28.333^{1}	Bayelsa
Brass	N04^{o} 31.500	E06^{o} 24.167	Bayelsa
Badagry	N04^{o} 25.012^{1}	E02^{o} 52.988^{1}	Lagos
Oron	N04^{o} 49.217^{1}	E008^{o} 04.625^{1}	Akwa Ibom
Ibaka	N04^{o} 27.200^{1}	E007^{o} 19.618^{1}	Akwa Ibom

Results and Discussions

Morphometric Analysis

Analysis of morphometric data showed that the first principal component (PC-I) accounted for 85.73% while the second (PC-II) accounted for 4.54% giving a total 90.27% of the variations in morphometric measurements data and were used to explain the variations (Table 2). The highest mean weight and total length (0.29±0.006kg and 0.24±0.002m, 0.27±0.004 kg and 0.23±0.001 m) respectively with the lowest coefficient of variation (15.8% and 11.9%) in terms of weight were found in Iwoama and Brass. The values were significantly different ($P<0.05$) from other locations (Table 3). Principal component analysis showed that samples from Brass and Iwoama (Bayelsa) formed a separate cluster from samples of other locations. While Ishaka forms an out-group suggesting that Iwoama and Brass populations are morphologically different from other populations (Figure 1). Cluster analysis illustrated by the dendrogram also revealed two major clusters which indicate that the ten populations clustered into two distinct groups revealing low variability among the populations of *T. guineensis* from the coastal locations studied (Figure not shown). This is in agreement with the report of Sun *et al*, (2012) who pointed out that populations of east coast of Indian Ocean and Pacific Ocean of *P. monodon* are morphologically similar. A similar observation was made by Thirumaraiselvi *et al.* (2013) in a morphometric study of three populations of Indian Salmon. This relatedness could be attributed to gene flow that might have existed among the populations.

Table 2. Principal component analysis of Morphometric variables

PC#	Eigen value	Variance (%)	Cumulative (%)	Std Deviation
1	11.146	85.73	85.73	3.33
2	0.591	4.54	90.28	0.76
3	0.369	2.84	93.12	0.60
4	0.294	2.26	95.38	0.54
5	0.198	1.52	96.91	0.44
6	0.099	0.76	97.67	0.31
7	0.075	0.57	98.24	0.27
8	0.711	0.55	98.79	0.26
9	0.049	0.38	99.17	0.22
10	0.039	0.30	99.48	0.19
11	0.033	0.25	99.73	0.18
12	0.023	0.17	99.91	0.15
13	0.012	0.09	100.00	0.11

Table 3. Descriptive Statistics for Mean Summary of Morphometric Characters of *T. guineensis* Populations Studied

Variables	Oropo		Badagry		Brass		Buguma		Epe	
	Mean±SE	**CV%**	**Mean±SE**	**CV%**	**Mean±SE**	**CV%**	**Mean±SE**	**CV%**	**Mean±SE**	**CV%**
Wt(kg)	0.049±0.002^{cd}	34.5	0.045±0.003^{c}	61.5	0.279±0.004^{g}	11.9	0.058±0.005^{de}	62.2	0.059±0.003^{de}	41.6
TL(m)	0.14±0.002^{e}	12.7	0.16±0.003^{e}	13.3	0.23±0.001^{f}	4.24	0.15±0.004^{c}	20.5	0.15±0.003^{cd}	13.9
SL	0.11±0.001^{c}	8.87	0.13±0.002^{f}	13.3	0.18±0.001^{g}	4.48	0.11±0.003^{c}	12.2	0.12±0.002^{d}	14.1
PDL	0.04±0.001^{b}	9.47	0.05±0.001^{c}	12.6	0.08±0.001^{d}	5.66	0.05±0.003^{c}	39.9	0.05±0.001^{c}	14.2
PAL	0.08±0.001^{c}	108	0.09±0.002^{de}	14.8	0.14±0.001^{f}	4.76	0.07±0.003^{b}	22.4	0.09±0.002^{d}	13.6
PPL	0.04±0.001^{c}	11.4	0.05±0.001^{cd}	13.5	0.07±0.001^{e}	4.62	0.05±0.003^{d}	40	0.04±0.002^{c}	24.1
PPEL	0.04±0.001^{de}	14.3	0.04±0.001^{e}	13.6	0.07±0.001^{f}	6.21	0.03±0.001^{c}	23.1	0.04±0.001^{d}	15.5
DFL	0.08±0.001^{e}	6.59	0.08±0.002^{e}	12.9	0.15±0.001^{f}	6.17	0.07±0.002^{c}	17.9	0.07±0.002^{c}	15.9
CFL	0.03±0.001^{de}	14.3	0.03±0.001^{ef}	12.9	0.05±0.001^{g}	9.17	0.03±0.002^{f}	32.3	0.03±0.002^{def}	35.5
AFL	0.03±0.001^{g}	11.2	0.03±0.001^{f}	31.2	0.06±0.00^{h}	4.61	0.03±0.001^{e}	21.7	0.02±0.001^{cd}	28.7
HL	0.04±0.001^{bc}	15.3	0.04±0.001^{d}	18.9	0.07±0.001^{e}	4.97	0.04±0.001^{c}	21.9	0.04±0.001^{c}	13.7
IOW	0.02±0.00^{de}	14.9	0.02±0.001^{e}	39.8	0.03±0.00^{g}	6.71	0.02±0.001^{d}	30.6	0.01±0.001^{b}	71.3
ED	0.01±0.00^{c}	11.2	0.01±0.00^{b}	30.1	0.02±0.00^{e}	7.7	0.01±0.001^{d}	25.2	0.01±0.00^{c}	19.8

Table 3. Descriptive Statistics for Mean Summary of Morphometric Characters of *T. guineensis* Populations Studied Contd.

Variables	Igbokoda		Ishaka		Iwoama		N.Calaber		R.Ethiope	
	Mean±SE	**CV%**	**Mean±SE**	**CV%**	**Mean±SE**	**CV%**	**Mean±SE**	**CV%**	**Mean±SE**	**CV%**
Wt(kg)	0.034±0.001^{b}	28	0.017±0.001^{a}	29.9	0.29±0.006^{h}	15.8	0.081±0.004^{f}	37.2	0.068±0.001^{e}	6.95
TL(m)	0.13±0.002^{b}	12.2	0.10±0.001^{a}	8.53	0.24±0.002^{g}	6.19	0.16±0.003^{de}	14.4	0.15±0.001^{cd}	3.01
SL	0.09±0.001^{b}	12	0.08±0.001^{a}	8.93	0.18±0.001^{g}	4.8	0.13±0.002^{ef}	14.9	0.12±0.001^{de}	3.69
PDL	0.04±0.001^{b}	11.4	0.03±0.001^{a}	19.3	0.08±0.001^{c}	7.03	0.05±0.001^{c}	16.7	0.05±0.00^{d}	3.22
PAL	0.07±0.002^{b}	14.2	0.06±0.001^{a}	13.3	0.14±0.001^{f}	5.63	0.09±0.002^{e}	17.4	0.09±0.00^{de}	2.16
PPL	0.04±0.001^{b}	12.5	0.03±0.001^{a}	12.4	0.07±0.001^{e}	7.12	0.05±0.001^{d}	13.9	0.05±0.00^{d}	3.11
PPEL	0.04±0.001^{b}	10.2	0.03±0.001^{a}	18.1	0.07±0.001^{f}	6.68	0.04±0.001^{de}	16	0.04±0.00^{e}	2.54
DFL	0.06±0.001^{b}	8.62	0.05±0.001^{a}	12.9	0.15±0.001^{f}	4.32	0.08±0.002^{d}	14.9	0.07±0.00^{c}	2.56
CFL	0.03±0.001^{bc}	25	0.02±0.001^{a}	14.6	0.005±0.001^{g}	6.39	0.03±0.001^{cd}	24.6	0.03±0.00^{b}	4.51
AFL	0.02±0.001^{b}	15.2	0.01±0.00^{a}	20.4	0.06±0.001^{i}	6.87	0.02±0.001^{de}	16.4	0.02±0.00^{c}	3.88
HL	0.04±0.001^{bc}	13.1	0.03±0.001^{a}	14.4	0.07±0.001^{f}	4.97	0.04±0.001^{c}	18.1	0.04±0.00^{b}	3.12
IOW	0.02±0.001^{c}	14.2	0.01±0.00^{a}	16.7	0.03±0.00^{f}	7.71	0.02±0.001^{c}	42.9	0.02±0.00^{c}	3.87
ED	0.01±0.00^{c}	22.9	0.01±0.00^{a}	16.7	0.01±0.00^{d}	9.14	0.01±0.00^{b}	29	0.01±0.00^{c}	2.89

Legend: WT- weight, TL -total length, SL- standard length, PDL- Pre-dorsal length, PAL- Pre- anal length, PPL- Pre-pelvic length, PPEL- Pre-pectoral length, DFL- dorsal fin length, CFL- caudal fin length, AFL- anal fin length, HL- head length and IOW- interorbital width.

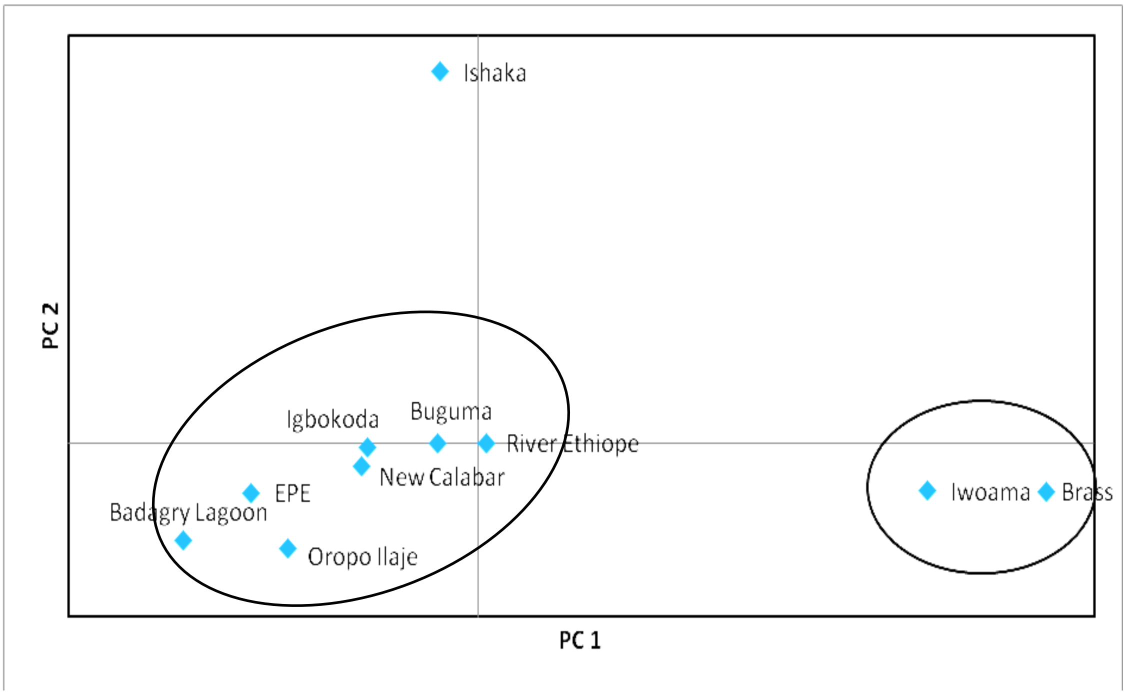

Figure 1: Principal component analysis of morphometric data based on location distribution of samples

Microsatellite Based differences in Populations

Morphological method has some limitations in studying variability among species populations. Microsatellites are among the most widely used DNA markers for many purposes such as diversity, species identification, genome mapping, etc. (Teixeira da Silva, 2005). The use of these markers to investigate genotypic variations among different populations has been previously reported by some researchers (Dang *et al*., 2014; Abdel-Kader *et al*., 2013). Nine microsatellite markers were utilized to characterize and investigate genetic variation in some coastal populations of *T. guineensis* with a view to stimulating interest and giving insights into possibilities of improving nutritional and economic qualities of *T. guineensis* through breeding and conservation programmes.

In the present study, Badagry in Lagos state population had the highest mean number of alleles (2.67), followed by Buguma in Rivers state (2.56) and Brass in Bayelsa state (2.44) while the lowest was found in Igbokoda in Ondo state (1.44). Generally, a total of 28 alleles were revealed, this is similar to the study of Abdul *et al*. (2012) who got a total 27 alleles in rice. This may imply that observation of 27- 28 alleles is sufficient for animal and plant diversity studies. In contrast, the study of Hassanien and Gilbey (2005) revealed 80 alleles in 6 loci from 5 populations of *Oreochromis niloticus* indicating higher genetic diversity than *T. gineensis*. This result suggests that *T. guineensis* had lower genetic diversity than *O. niloticus.* Urgent steps are therefore necessary to arrest further reduction in diversity of *T. guineensis* through various breeding and conservation programmes.

The mean effective alleles varied from 1.29 to 2.11. In all populations, the mean effective number of allele was lower than the mean number of alleles. Shannon information index was observed higher in Buguma population (0.77), Badagry (0.76) and Brass (0.64) reflecting high genetic diversity while other populations had low index. All populations showed low average observed heterozygosity. Badagry was the most variable (Ho = 0.467) followed by Buguma (Ho = 0.402) and Brass (Ho = 0.456) while Oron had the least observed heterozygosity (Ho = 0.211). The average expected heterozygosity was high in Buguma (0.503), Badagry (0.484) and Brass (0.411) and low in Oron (0.178) and Igbokoda (0.180) populations as shown in Table 4. Three populations (Buguma, Badagry and Brass) were identified as having the highest biodiversity in this study based on mean number of alleles, Shannon's information index and heterozygosity (observed and expected) when compared to others and are therefore considered as suitable areas for sourcing *T. guineensis* for improvement through breeding.

Moreover, clustering based on genetic distance revealed four clusters indicating some level of genetic variability between the studied populations (Figure 2).

Table 4. Summary of the Genetic Diversity Level in the Twelve Studied Populations

Population	Na	Ne	I	Ho	He
Buguma	2.7	2.11	0.77	0.402	0.503
New Calabar	1.7	1.53	0.36	0.400	0.247
Ishaka	2.2	1.49	0.44	0.333	0.273
River Ethiope	2.2	1.69	0.54	0.289	0.336
Epe	1.9	1.47	0.36	0.344	0.236
Igbokoda	1.4	1.35	0.25	0.300	0.180
Oropo	2.0	1.58	0.44	0.233	0.286
Iwoama	1.9	1.39	0.36	0.244	0.225
Brass	2.4	1.87	0.64	0.456	0.411
Bdagry	2.7	2.09	0.76	0.467	0.484
Oron	1.7	1.27	0.27	0.211	0.178
Ibaka	1.8	1.33	0.31	0.233	0.202

Legend: NA- number of alleles, NE- effective number of alleles, I- shannon information index, Ho- observed heterozygosity and He- expected heterozygosity.

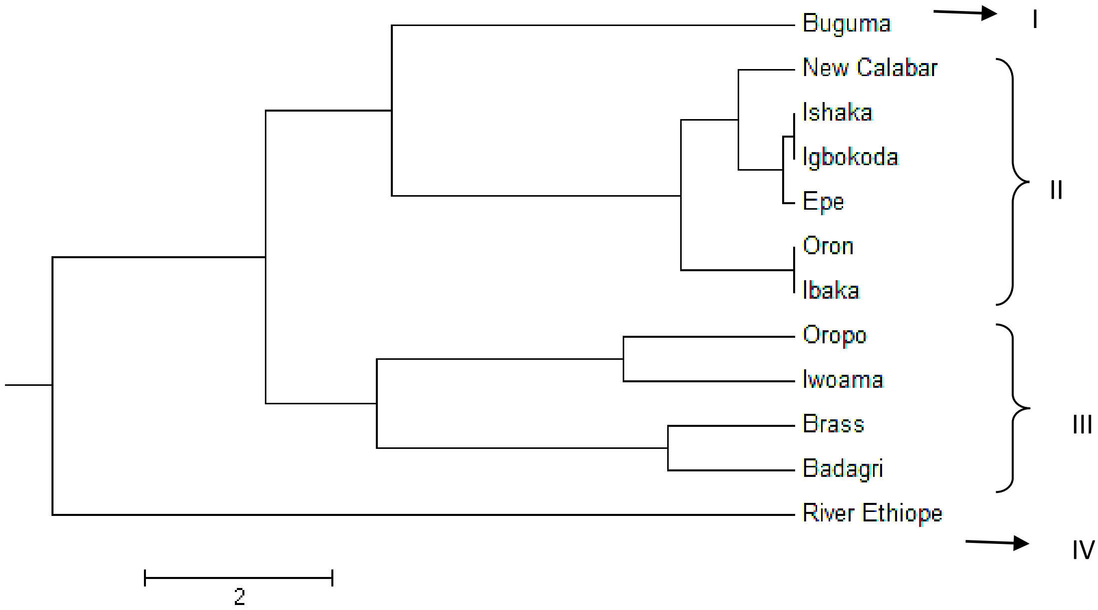

Figure 2. UPGMA Dendrogram Showing the Genetic Relationships among 12 Populations Based on Nei's Genetic Distance.

Morphology and Genetic Diversity of the Studied Populations

Using morphological and molecular data to quantify differentiation between populations of *T. guineensis* from coastal locations, some level of variation was observed morphologically and genetically between and among these populations. This study has provided significant knowledge on *T. guineensis* population differentiation. Rivers, Lagos and Bayelsa states show greater genetic and morphological divergence. Although it could be that the variation observed in morphology were significantly correlated with some genetic factors more than environmental factors. However, genetic data collected from the populations slightly support the morphological results.

Furthermore, it can be deduced that genetic differences may not always be represented by phenotypic variation. This may be due to phenotypic plasticity of fish that allows them to respond adaptively to environmental change (Lefébure *et al.*, 2006). Therefore, it has been highlighted the importance of utility of genetic information in stock differentiation and conservation studies for wild population of *T. guineensis*.

Conclusion

The present study revealed some level of morphological and genetic variation between and among the *T. guineensis* populations. *Tilapia guineensis* populations in Buguma (Rivers State), Badagry (Lagos State) and Brass (Bayelsa State) are the most morphologically and genetically diverse and are therefore recommended as starting populations for fish improvement through selective breeding in Nigeria.

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Assessment Of Open Pollinated Exotic Sweetpotato Seedlings for Variation in Flesh Root Colour and Response to Pests and Diseases in Umudike Southeastern, Nigeria

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Abstract

One thousand three hundred and two (1302) sweetpotato seedlings from 12 families were evaluated using a single plant seedling evaluation trial in an unreplicated block design at National Root Crops Research Institute Umudike experimental field with the following objectives: to determine the percentage survivability of the transplanted seedlings, the storage root fleshed colour of individual seedlings developed from open pollination and the response of the sweetpotato seedlings to pests and diseases attacking the crop in the field. Data collected were on: percentage survivability, the response of the seedlings to diseases attacking sweetpotato crops in the field, root colour variation of the respective seedlings using sweetpotato colour chart. Result obtained indicated that nine different colours were observed from the sweetpotato seedlings evaluated. Out of the number that survived in the field, 231 was deep orange root flesh colour and the highest, followed by 220 seedlings with orange roots flesh colour while the least colour was one seedling with white fleshed root mixed with purple. No symptom of the major diseases attacking sweetpotato crop in the field was observed on the seedlings. Since the deeper the orange colour of the roots, the higher the Beta-carotenoid content which is the precursor for vitamin A, These seedlings will be further evaluated for other characteristics for possible release for commercial sweetpotato cultivation.

Keywords: sweetpotato, seedlings, flesh colour, diseases and families.

Introduction

Sweetpotao (Ipomoea batatas L Lam) are commonly grown in every part of Nigeria and one of the major crops, used for animal feed and human foods as well as means of economic empowerment to many poor resource farmers. More than 60% of the farmers engage in sweetpotato farming and it remains a prominent food crop to many rural dwellers especially in Northern parts of the country (Edebiri, et al., 2001). There are many varieties of sweetpotato with variation in root skin and root flesh colour such as white, cream, yellow, orange and purple. Sweetpotato is a cheap source of beta carotene, carbohydrate, vitamins and other nutrients. Some of the sweetpotao varieties such as purple and orange are very important in fighting cancers; reduce incidence of blindness and incidence of malnutrition which is in high rate among children and pregnant woman. The purple sweetpotato root flesh colour is packed with some antioxidant that provided anthocyanine which boost immunity. These medicinal factor of sweetpotato led to the selection of flesh root colour as priority for selection. Martin and Jones (1986) emphasized that the root yield traits was not the highest priority for selection. Also, worldwide, the greatest disease and pest of sweetpotato is SPVD. Resistance sweetpotao genotypes to SPVD are needed by the breeding programmes for introgression of resistant genes to new progenies (Mwanga et al., 2002.).

Breeding involves the selection of new varieties from true botanical seeds which in the process will lead to identification of genotypes with desirable traits to create new and better population for future selection. Therefore the aim of this study was to determine the percentage survivability of the transplanted seedlings, the storage root fleshed colour of individual seedlings developed from open pollination and the response of the sweetpotato seedlings to pests and diseases attacking the crop in the field.

Materials and Methods

True seeds were raised in the screen house and transplanted as seedlings to the field two months after planting in the screen house. A total of 1302 sweetpotato seedling from 12 families were planted in an unreplicated block. The seedlings were evaluated using a single plant seedling evaluation trial. Each seedling was carefully removed from the polybag after loosening the soil around them, the single plants were planted at the crest of the ridge at a spacing of 1.0m x1.0m intra and inter row spacing. Agronomy practices such as weeding and fertilizer application at 4 weeks after planting were carried out. Data were collected on percentage survivability, the response of the seedlings to diseases attacking sweetpotato crops while growing in the field. At harvest, data were collected on root colour variation of the respective seedlings using sweetpotato colour chart (Burgos et al., 2009). The percentage survivability of the seedlings was calculated using the formula

$$\text{Percentage survivability:} \quad \frac{\text{Total number of seedlings survived}}{\text{Total number of seedlings transplanted}} \text{X } 100$$

Diseases were visual scored using 5 point severity rating scale where 1= no symptom, 2= mild symptom, 3= moderate symptom, 4=severe symptom and 5= very severe symptom.

Results and Discussions

The result indicated that total number of 1302 sweetpotato seedling from 12 families was transplanted to the experimental field. Number of seedlings survived was 981 which represented 75.5% survivability. The result showed that there is genetic variance among the population, since most seedling show fitness of adaptation to our harsh environment. The result is in line with the finding of (Nwankwo et al., 2015) that high percentage field establishment showed high adaptability of the seedling to the harsh field conditions (Table 1).

The result in Table 2 show various sweetpotato root flesh colour of the seedlings from 12 families. Two hundred and thirty-one seedlings (231) have deep orange root flesh colour, 220 seedlings have roots flesh colour that is orange, 114 were seedlings with yellow roots flesh colour while root flesh colour of 13 seedlings were white. The root flesh colour of 84 seedlings was light orange while the root flesh colour of 54 seedlings was cream. The root flesh colour of some seedlings was mixed. For example 43 seedlings have root flesh colour yellow mixed with orange, 9 seedlings had their root flesh colour orange mixed with purple while one seedling had its root flesh colour which is white mixed with purple.

The sweetpotato seedlings with orange deep orange and purple colour indicated presence of βeta carotene and anthocynine contents which are rich in boosting the immunity of children under five years against blindness and have cancer fighting properties.

The table 3 shows the response of the sweetpotato seedlings to major sweetpotato folia diseases attacking the crop in the field. Sweetpotato virus diseases, Sweetpotato bacteria blight and sweetpotato leaf spot showed 100% no visible symptom at rating scale of 1 severity. This indicated complete absence of these diseases attacking the seedlings in the field. This an indication of good characteristics which farmers want in any new variety.

Conclusion

Nine different colours were observed from the sweetpotato seedlings evaluated. Deep orange root flesh colour from 231 seedlings was the highest, followed by 220 seedlings with orange roots flesh colour while the least colour was one seedling with white fleshed root mixed with purple. No symptom of the major diseases attacking sweetpotato crop in the field was observed on the seedlings. Since the deeper the orange colour of the roots, the higher the Beta-carotenoid content which is the precursor for vitamin A, These seedlings will be further evaluated for other characteristics for possible release for commercial cultivation.

Table 1: Variation in fleshed root colours of sweetpotato seedling from 12 families

Family Names	Roots Flesh Colour									
	Total	**CR**	**WT**	**OR**	**DO**	**LO**	**YE**	**YxO**	**OxP**	**WxP**
Moza9-/v.52	109	22	1	15	23	17	22	7	1	1
Moza2-51/v.39	199	0	0	103	61	14	12	3	6	0
Moza1-3/v.8	73	5	2	6	27	13	6	13	1	0
Tio Joe/p.5	44	2	0	17	14	0	9	2	0	0
Moza 9-26/v.12	42	0	0	17	14	0	7	2	0	0
Moza 12-26/v.10	57	5	1	6	20	10	4	10	1	0
moza4-7/v.v1.	17	1	0	2	5	3	6	0	0	0
Moza 65-21/v.43	28	1	1	2	7	6	10	1	0	0
Moza 6-20/v.u8	14	0	1	4	3	0	6	0	0	0
Moza 121022-10/v.21	16	0	0	5	2	3	6	0	0	0
Moza 12-17/v.53	8	0	0	0	4	0	3	0	1	0
Moza11033-6/v.15	3	0	0	3	0	0	0	0	0	0
AYT-16CO-15/T.11	12	4	4	0	0	4	0	0	0	0
GP105413-4/T.16	48	9	2	8	9	5	10	5	0	0
GP10703118/T.16	14	0	0	1	5	2	6	0	0	0
AYT-16CN1448-49-28/T.6	19	0	0	10	4	0	5	0	0	0
AYT16-EN49-37/T.7	3	0	0	0	2	1	0	0	0	0
AUY-1613-ORCA350A-9/T.8	24	3	1	3	12	5	0	0	0	0
GPC-15/T.25	15	3	0	5	6	0	1	0	0	0
AYT-16GYL488-49-28/T.6	20	0	0	8	10	1	1	0	0	0
Moza9-/v.52	8	0	0	5	3	0	0	0	0	0
Total		**54**	**13**	**220**	**231**	**84**	**114**	**43**	**9**	**1**

Note CR-Cream, WT-White, OR-Orange, Do-Deep Orange, Lo-Light Orange, Ye- Yell0w, YxO-Yellow, Mixed Orange, OXP-Orange Mixed Orange, WXP –White Mixed Purple

Table 2: Response of the sweetpotato seedlings to major sweetpotato diseases

Family Names	NSP	SPVD		SLBB		LEAF SPOT	
		Incidences	Mean Severity	Incidences	Mean severity	Incidences	Mean severity
Moza9-/v.52	248	0	1	0	1	0	1
Moza2-51/v.39	259	0	1	0	1	0	1
Moza1-3/v.8	161	0	1	0	1	0	1
Tio Joe/p.5	65	0	1	0	1	0	1
Moza 9-26/v.12	57	0	1	0	1	0	1
Moza 12-26/v.10	122	0	1	0	1	0	1
moza4-7/v.v1.	21	0	1	0	1	0	1
moza 65-21/v.43	48	0	1	0	1	0	1
moza 6-20/v.u8	21	0	1	0	1	0	1
moza 121022-10/v.21	30	0	1	0	1	0	1
moza 12-17/v.53	18	0	1	0	1	0	1
moza11033-6/v.15	8	0	1	0	1	0	1
AYT-16CO-15/T.11	12	0	1	0	1	0	1
GP105413-4/T.16	60	0	1	0	1	0	1
GP10703118/T.16	19	0	1	0	1	0	1
AYT-16CN1448-49-28/T.6	27	0	1	0	1	0	1
AYT16-EN49-37/T.7	5	0	1	0	1	0	1
AUY-1613-ORCA350A-9/T.8	55	0	1	0	1	0	1
GPC-15/T.25	15	0	1	0	1	0	1
AYT-16GYL488-49-28/T.6	21	0	1	0	1	0	1
Moza9-/v.52	15	0	1	0	1	0	1

NOTE: NSP- number seedlings planted, SPVD-sweetpotato virus disease, SLBB- sweetpotato leaf bacteria blight5 point severity rating scale where 1= no symptom, 2= mild symptom, 3= moderate symptom, 4=severe symptom and 5= very severe symptom

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Genetic Variability Studies of Tomato (*Solanum lycopersicum* l.) Accessions

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Abstract
The extent of genetic variability among 19 accessions of tomato (Solanum spp) was studied using genetic variability parameters as a basis for harnessing of the crop. Four-week old seedlings were transplanted in a well levelled field with 0.6 x 0.6 spacing and replicated three times in randomized complete block design. High significant differences among the accessions for all attributes studied. Cluster analysis based on 37 agro-morphological attributes separated accessions into two distinct groups according to the fruit types i.e. cherry and classic fruit types. Values for genotypic and phenotypic coefficients of variation showed variability among the accessions. Correlation analysis showed fruit per plant is positively and significantly correlated to plant height, number of branches per plant and leaf length. Very high genetic advance and heritability estimates for leaf length, leaf width, days to flower, days to 50% flowering, number of fruits per plant, fruit length, fruit diameter, fruit weight and 1000 seed weight suggest simple inheritance system and thus amenability for these attributes to selection in tomato improvement.
Keywords: *Tomato, attributes, variance, heritability, genetic advance, inheritance.*

Introduction
Tomato (*Solanum lycopersicon* L.) is one of the most important vegetable crops grown over the world because of its wider adaptability, high yielding potential and suitability for variety of uses in fresh as well as processed food industries. It is one of the most important vegetable crops grown in Nigeria and utilized in almost every household for preparation of several dishes. Tomato plays an important role in human nutrition by providing essential amino acids, vitamins and minerals (Sainju *et al.,* 2003). Its vitamin C content is particularly high (Kanyomeka and Shivute, 2005). It also contains lycopene, a very potent antioxidant that may be an important contributor to prevention of cancers (Agarwal and Rao, 2000). With production of over 150 million tons of fresh fruit on 3.7 million hectares tomato exceeds the production of all other crops, with the exception of the potato and sweet potato (FAOSTAT, 2014). Production in Nigeria has more than doubled in the last 10 years with the production in 2001, amounting to about 879,000 tonnes (Akanbi and Oludemi, 2003). However, commercial tomato production in Nigeria relies mostly on exotic introductions. The production of which is essentially restricted to the Northern Guinea Savanna and the Sudan ecologies due to favourable climatic conditions, particularly high insolation and low relative humidity. In nearly three decades, up to 2013, no tomato variety has been released in Nigeria (NACGRAB and NASC, 2013). The need therefore, to explore the production capabilities and potentials of long forgotten indigenous land races and other ecotypes has never been more urgent.

The concept of heritability combined with genetic advance are good parameters for determining gene action involved in the inheritance of any trait and by extension help in deciding the best breeding method to apply for improving such trait. High heritability indicates less environmental influence in the observed variation (Songsri *et al*., 2008; Eid, 2009), while high heritability accompanied by high genetic advance is an indication of additive gene action for such trait, making it most amenable to selection (Tazeen, *et al*., 2009). This study was carried out to determine the extent of genetic variation among available tomato accessions with the specific objective to use suitable genetic parameters as basis for future breeding work in tomato.

Materials and Method

Nineteen (19) accessions of tomato held in National Genebank at the National Centre for Genetic Resources and Biotechnology (NACGRAB) were used in this experiment. The accessions were seeded in nursery trays filled with top soil. Seedlings were transplanted at four weeks after planting (WAP) to NACGRAB research field, Moor Plantation (224m, 7°23`, 3°50`), Ibadan, Nigeria in 2013 rainy season. Seedlings were transplanted unto a well ploughed, harrowed and levelled field. Inter and intra-row spacing was 0.6 x 0.6m. Each treatment accession was in single 6 meter row plot replicated thrice in a completely randomized block design. Recommended cultural practices were followed. Data were recorded from five pre-tagged plants of each treatment. Attributes measured and recorded using descriptors for Tomato (*Solanum* spp.) (IBPGR, 1997). Data analysis of variance was done and significant means were separated using Duncan multiple range test (DMRT) SAS 9 (SAS, 2002). Mean values were used to estimate Genotypic and Phenotypic coefficients of variation as by Singh and Chaudhury (1985). The broad sense heritability and genetic advance were calculated as proposed by Johnson *et al*. (1955) and UPGMA cluster analysis was used to construct a dendogram to ascertain the genetic relationships among the tomato accessions.

Results and Discussions

Significant differences were shown among the accessions for all morphological characteristics measured, with genetic distance ranging from 0.30 to 0.49 (Fig. 1). In this study, the cluster analysis based on 37 agro-morphological attributes that separated accessions into two distinct groups at 0.32 coefficient, which were according to fruit types – into cherry and classic fruit groups corresponding to varietal types (Fig 1). This is similar to the results of Kwon *et al*. (2009) who characterized 63 tomato varieties of Korea using SSR markers and morphological descriptors. The 20 qualitative attributes had two to nine numbers of observable types. Eight attributes (40%) had more than two types, of which fruit shape had the largest variation with six types (slightly flattened, flattened, cylindrical, rounded, ellipsoid and high rounded). Hu *et al.* (2012) reported that fruit shape had the most variable types (seven). There were no obvious differences for five attributes (leaf type, division of leaf blade, stem pigmentation, abscission layer and flower colour) among the accessions studied.

Highly significant differences among the accessions for most attributes studied (Table 1) suggests enough genetic variability of the accessions hence the scope for improvement of this crop. Similar observations have been reported on 14 characters (Singh and Raj, 2004; Hidayatullah, *et al*., 2008) and all characters studied by Mohammed *et al*. (2012). Values of genotypic and phenotypic variances were lowest in peduncle length and highest in fruit yield per plant. Higher values of genotypic and phenotypic variances observed for most attributes suggest the existence of high magnitude of variability among the accessions with respect these attributes. Smallest differences observed between PCV and GCV values of attributes such as leaf length, leaf width, days to flower, days to 50% flower, days to fruit ripening, fruit length, fruit per inflorescence, fruit diameter, fruit weight, days to maturity and 1000 seed weight (Table 1) suggest lesser influence of environmental factors on their expression. Selection for improvement of tomato for these attributes is likely to be most effective. Relatively higher differences between PCV and GCV values recorded for plant height, number of branches, number of leaflets, fruit per plant, peduncle length and fruit yield indicate more influences of environmental factors than other attributes studied.

Very high heritability estimates for leaf length, leaf width, days to flower, days to 50% flowering, fruit per plant, fruit length, fruit diameter, fruit weight and 1000 seed weight (Table 3) indicate possibility of their improvement through selection. Similar results have been reported by Tasisa *et al*. (2011) and Ulla *et al*. (2012). However, Parnse (1957) stated that greater usefulness of considering estimate of genetic advance as an effective selection tool lies in accompanied heritability estimates. Hence, very high genetic advance accompanied by high heritability estimates for leaf length, leaf width, days to flower, days to 50% flowering, fruit per plant, fruit length, fruit diameter, fruit weight and 1000 seed weight suggest simple inheritance system for these traits. Fehmida and Ahmed (2007) reported similar results for plant height, number of fruits per plant, fruit size and weight of 10 tomatoes.

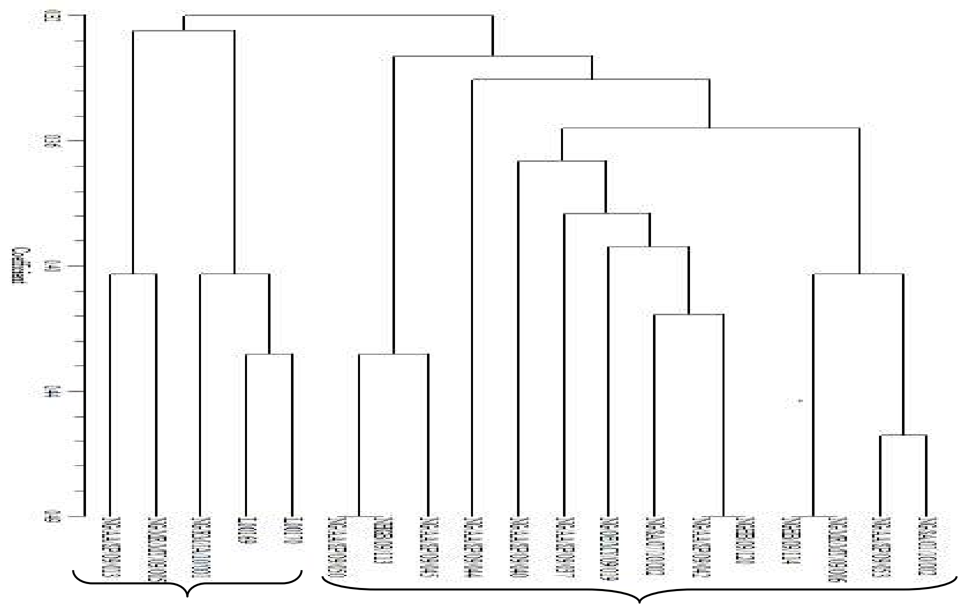

Figure I:- Dendogram of 19 tomato accessions based on 37 agro-morphological attributes and generated from average taxonomic distance matrix by UPGMA in NYSYSpc.

Table 1:- Analysis of variance, estimates of phenotypic variance (σ^2p), genotypic variance (σ^2g), heritability (H^2b), genotypic and phenotypic coefficients of variability and genetic advance for various attributes of tomato accessions.

Attribute	Accession mean	P-value ≤	σ^2g	σ^2p	σ^2e	H^2b (%)	GCV	PCV	GA
Weight/fruit (g)	36.74	0.001	21.89	40.75	18.86	54	35.60	48.58	53.75
1000 Seed weight (g)	2.29	0.001	319.60	499.91	180.31	64	17.68	22.11	29.12
No of days to flowering	42.40	0.001	31.08	31.95	0.87	97	18.82	19.08	38.23
No of days to 50% flowering	49.40	0.001	11.89	13.55	1.70	88	17.18	18.37	33.11
No of days to fruit ripening	76.04	0.001	203.41	441.06	237.64	46	38.90	57.29	54.43
No of days to fruit maturity	78.65	0.001	33.23	41.75	8.53	80	13.59	15.24	24.98
Plant height (cm)	13.14	0.001	86.43	105.79	19.37	82	18.82	20.82	35.04
Number of leaflets	38.66	0.001	21.27	36.65	15.39	58	6.06	7.96	9.52
Number of branches	7.11	0.001	1.88	2.40	0.52	78	26.67	30.15	48.60
Peduncle length (cm)	0.51	0.05	4349.08	4826.12	477.04	90	118.5	124.8	231.7
No of fruit/inflorescence	5.14	0.001	0.01	0.02	0.01	39	18.54	29.53	23.98
Fruit length (mm)	35.98	0.001	144.05	149.06	5.01	97	33.36	33.93	67.55
Fruit diameter (mm)	38.01	0.001	144.09	160.49	16.40	90	31.58	33.33	61.64
No of fruit/peduncle	55.69	0.001	672.56	772.6	99.6	100	75.58	75.63	135.7
Leaf length(cm)	29.63	0.001	28.07	31.94	3.88	88	6.72	7.17	12.98
Leaf width (cm)	20.07	0.001	0.35	0.35	0.0	100	25.85	28.85	53.24
Fruit yield per plant (g)	1269.64	0.001	775796.1	1049841.9	274045.5	74	63.37	80.70	122.9

σ^2g = genotypic variance, σ^2g = phenotypic variance, GCV = genotypic coefficient of variation, PCV = phenotypic coefficient of variation, GA= Genetic advance, H^2b = heritability in broad sense

Conclusion

The genetic parameters discussed here are functions of environmental variability, so estimates may differ in other environments. However, based on the high genetic advance accompanied by high heritability estimates for different attributes studied, especially, days to 50% flowering, fruit per plant, fruit length, fruit diameter, fruit weight and 1000 seed weight we could conclude that the determinant genetic effects of the phenotypic expression of these characters are fundamentally of the additive type. Hence, a high response should be achievable after several selection cycles.

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Effect of Maize Crop Residue Biochar on Pepper Performance in Minna, Nigeria

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Abstract
The experiment was conducted at the Horticultural Nursery of Federal University of Technology Minna, Nigeria, to determine effect of maize crop residue biochar on pepper performance in Minna. The treatments were five rates of maize crop residue biochar application (0, 5, 10, 15 and 20 tons ha^{-1}), laid down in a Completely Randomized Design (CRD) with four replications. Data collected were plant height, number of leaves, number of days to flowering, fresh and dry biomass and fruit yield. The results showed that the textural class of the soil was sandy loam, soil reaction was slightly acidic (pH 6.7), low in organic carbon (3.60 g kg^{-1}), medium in total nitrogen (0.14 g kg^{-1}) and relatively high in available P (20.72 mg kg^{-1}). Application of 10 ton ha^{-1} of maize crop residue biochar produced the highest number of leaves, fresh and dry biomass weight, fruit yield and organic content of the soil. 10 ton ha^{-1} of maize crop residue biochar can be considered useful for the cultivation of pepper in a pot experiment.
Keywords: Biochar, maize crop residue, and Minna

Introduction
Pepper (*Capsicum frutescence*) is an important fruit vegetable which belongs to the night shade family Solanaceae, and is related to eggplant, potato and tobacco. It is the second most important vegetable after tomatoes, it now commonly cultivated in all parts of the world. The bulk production of pepper is found in the Savanna zone and derived Savanna areas of the south western Nigeria. Nigeria produced 0.63 million metric tonnes (MT) pepper fruits in 1980 (FAO, 1980) which increased to 1.793 million MT in 2009 (FMARD, 2010). Nevertheless, pepper yield is still low, at average of 3.85 MT.ha-1, and with much lower values obtained in the southern states due to many constraints. Pepper has increased in popularity, value and importance over a long period, thus making it an indispensable part of the daily diet of millions of Nigerian. It is an important source of vitamin A and C, which protects the body against disease attack. These vitamins in pepper help in maintenances of bones, tissues and blood and in the efficient utilization of iron. Pepper is normally used as a spice in the preparation of soup and stew when cooked with tomatoes and onions. It can also be used as a condiment and extensively in flavouring of processed meat, colouring certain food preparation and also used for medicinal purposes (Chauhan, 1972). Biochar therefore can possibly help alleviate environmental change by means of carbon sequestration. Freely, biochar can expand soil ripeness of acidic soils (low pH soils), increment rural efficiency, and give security against some foliar and soil-borne maladies. Recently, it has been observed that inadequacy in soil fertility and deficiency in important mineral nutrient has possessed serious constraints to high yield of pepper production (Fagwalawa and Yahaya, 2016). This is because fertilizer has become a scarce commodity, even when available; it is beyond the reach of the poor resource farmers due to its high cost (Fagwalawa and Yahaya, 2016). In moist tropical environment, sustainable agriculture faces large constraints due to low nutrient content and accelerated mineralization of soil organic matter (Yeboah *et.al*., 2013). The natural issue is typically mineralized quickly and just a little

extent of the connected natural issue is settled in the dirt in the long haul, however progressively discharged to the climate as CO2 (Yeboah *et.al.,* 2013). The way that various feedstuff, for example, plant deposits, maize crop residues etc. are accessible and are considered as contaminations, these waste materials can be burned and used valuably in farming. Consolidation of biochar to the dirt is advantageous in catching water to build soil dampness maintenance and accessible nitrogen hence the objectives of the study is to determine the effect of maize crop residue biochar on pepper performance and some soil chemical parameters like soil organic carbon, total nitrogen and available phosphorus.

Materials and Methods

This experiment was conducted at Horticultural Nursery, Federal University of Technology, Gidan Kwano Minna. In the Southern Guinea Savanna of Nigeria. The pots were filled 10 kg soil. There were 5 treatment which are; 0 t ha^{-1}, 5 t ha $^{-1}$,10 t ha^{-1}, 15tha^{-1-}, 20 t ha^{-1}. The experiment was laid on a completely design (CRD) with four replications. The maize crop residue biochar was mixed thoroughly two week before sowing. Pepper seed was sown by broadcasting method on nursery bed; three seedlings were transplanted into the pot at two week after emergence. The seedling was later thinned to one seedling per pot. Water was applied on daily basis. Weeding was done on regular basis by hand pulling. Soil samples were collected randomly from the Teaching and Research Farm. The soil samples were collected from each pot at the end of the experiment to determined soil chemical analysis. Sampling was done within depth of 0 – 15cm using shovel. The samples was bulked together to form a composite sample which was air-dried and analysed for particle size and some chemical properties using the standard procedures. Soil particle size distribution was determined by the hydrometer method . Soil pH was determined in a 1:2.5 soil to water with a pH meter, while the soil organic carbon was determined using the Walkley and Black wet oxidation method , total nitrogen by the micro- Kjeldhal method. Exchangeable bases were extracted with neutral 1 N NH_4OAC extraction. Na and K in the extract was determined using Flame photometry while the Ca and Mg was determined by Na-EDTA titration. Exchangeable acidity was extracted and then determined by titrimetric method and phosphorus was extracted and phosphorus was extracted using Bray P-1 method and the concentration was determined colorimetrically using atomic absorption spectrophotometer. The height of pepper was measured from the base of the plant to the tip of the plant using meter rule at 2, 4, 6, 8 10, 12 week after transplanting (WAT). The number of leaves was determined by counting of leaves on the plant at 2,4 6,8, 10,12 WAT. The days to flowering was done by visual assessment on the pepper. The number of days was calculated from the day of sowing to the date when first flower appear on each treatment pot. The number of flower was determined by counting the number of flower on each treatment pot. All the fruit harvested from the pot of each of the treatment pot was weight and recorded as fruit yield and the biomass was harvested and weighted as fresh biomass and weighed after drying as dry biomass. Data collected was subjected to analysis of variance (ANOVA) treatment means was compared using the Duncan Multiple Range Test (DMRT) at 5% level of probability.

Results and Discussion

Some Soil Physical and Chemical Properties

The soil physical and chemical properties before sowing are shown in Table 1. The textural class of the soil was sandy loam. The soil was slightly acidic in water (pH 6.7) and the organic carbon (3.62 g kg^{-1}) was low, medium in total nitrogen (0.14 g kg^{-1}) with relatively high available phosphorus (20.72 mg kg^{-1}) (Esu, 1991)

Effect of maize crop residue biochar on growth and yield of pepper

The effect of maize crop residue biochar on plant height of pepper at different growth stage is shown in Table 2. At 2 WAT, 20 ton ha^{-1} were significantly taller ($p<0.05$) than other treatments. At 6 WAT, 20 ton ha^{-1} were significantly taller ($p<0.05$) than 0, 5 and 10 ton ha^{-1} but similar to 15 ton ha^{-1}. At 8 WAT, 20 ton ha^{-1} were significantly taller ($p<0.05$) than 0, and 5 ton ha^{-1} but similar to 10 and 15 ton ha^{-1}. Similar trends were observed at 10 and 12 WAT. There was however no significantly difference among the treatment at 4 WAT. The effect of maize crop residue biochar on number of leaves of pepper at different growth stage is shown in Table 3. At 2 WAT, 15 and 20 ton ha^{-1} had the higher number of leaves which was significantly higher ($p<0.05$) than 5 ton ha^{-1}. There was no significantly difference among the treatment at 4 WAT. At 10 WAT 15 and 20 ton ha^{-1} had the higher number of leaves which was significantly different ($p<0.05$) from 5 ton ha^{-1} and control, similar trends was observed at 12 WAT.

Table 1: Some physical and chemical properties of soil prior to sowing

Parameters	Value
Sand (g kg $^{-1}$)	764
Silt (g kg^{-1})	130
Clay (g kg^{-1})	106
Textural class	Sandy loam
pH water	6.7
Organic carbon (g kg^{-1})	3.60
Available phosphorus (mg kg^{-1})	20.72
Total nitrogen (g kg^{-1})	0.14
Exchangeable bases (cmol kg^{-1})	
Ca^{2+}	4.60
Mg^{2+}	2.70
K^{+}	0.23
Na^{+}	0.08
Exchangeable acidity (cmol kg^{-1})	0.12
ECEC	7.73

Table 2: Effect of maize crop residue biochar on plant height of pepper

	Plant height (cm)					
Treatment	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
Control	5.50^{b}	7.33^{a}	9.17^{b}	9.67^{c}	10.00^{c}	12.00c
5 ton ha^{-1}	5.17^{b}	6.50^{a}	8.67^{b}	11.33^{bc}	12.67^{bc}	14.00^{bc}
10 ton ha^{-1}	5.33^{b}	7.33^{a}	10.00^{b}	13.00^{bc}	14.67^{b}	16.50^{bc}
15 ton ha^{-1}	6.33^{b}	9.50^{a}	11.33^{ab}	15.17^{ab}	16.00^{ab}	18.00^{ab}
20 ton ha^{-1}	9.00^{a}	11.33^{a}	11.33^{a}	19.00^{a}	20.00^{a}	21.17^{a}
SE±	0.49	0.72	0.95	1.00	1.03	1.00

Means with the same letter(s) in a column are not significantly different at 5% level of probability
WAT: week after transplanting.

Table 3: Effect of maize crop residue biochar on number of leaves of peeper

	Number of leaves					
Treatment	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
Control	6^{ab}	9^{a}	11^{bc}	15^{b}	18^{b}	23^{c}
5 ton ha^{-1}	4^{b}	6^{a}	9^{c}	13^{b}	18^{b}	24^{bc}
10 ton ha^{-1}	6^{ab}	8^{a}	11^{bc}	20^{a}	24^{a}	28^{abc}
15ton ha^{-1}	7^{a}	10^{a}	13^{ab}	20^{a}	27^{a}	33^{a}
20 ton ha^{-1}	7^{a}	51^{a}	14a	21^{a}	27^{a}	31^{a}
SE±	0.45	8.25	0.61	0.93	1.25	1.30

Mean with the same letter(s) in a column are not significantly different at 5% level of probability.
WAT: week after transplanting

The control flower earlier which was significantly different from 20 ton ha^{-1} that flower at the later days (Table 4). 10 and 20 ton ha^{-1} had the highest fruit yield which was significantly different ($p<0.05$) from other treatments (Table 4). Effect of maize crop residue biochar on fresh and dry biomass of pepper was shown in Figure 1. The treatment 15 ton ha^{-1} recorded the highest fresh biomass and the lowest was observed in control. Similar results were observed on dry biomass of pepper. The application of organic fertilizer like biochar have shown to enhance crop and soil quality (OIowokere 2004). Remain of organic based fertilizer have shown to increase the growth of crop such as pepper (Berova *et al.,* 2010). The application of biochar to soil improves the physical and chemical environment in soil providing microbes with a more favourable habitat. This consequence aid the transformation of nitrogen held in organic form to form available for uptake by plant roots potentially improving its availability to plant (Sandip and Harsha 2013).). Biochar provide a suitable habitat for many micro-organisms by shielding them from predation and desiccation and also provide diverse carbon energy mineral nutrient needed to plant (Warnock *et al.,* 2007). The effect of maize crop residue biochar on total nitrogen, organic carbon and available phosphorous is shown in Table 5. Treatment 10 ton ha^{-1} significantly increased organic carbon content while 15 ton ha^{-1} increased the available phosphorous but there was no significantly different from total nitrogen of the soil (Table 5). Positive change in soil chemical properties been recorded for different soil as result of application of biochar. These include increase in cation exchange capacity and pH of the soil (Liang *et al*; 2006; Cheng *et al*; 2008). Biochar also show as an increase in the availability of major cation phosphorus as well as total nitrogen concentration (Glaser *et al*., 2002; Lehmann *et al*., (2003). The volatilization of crop residue to biochar and introduction into small holder vegetable cropping system is suggested for restoring soil nitrogen in the vegetable farm as well as modifying the environmental for bioavailability and efficiency of nutrient in soil (Tagoe *et al; 2008*).

Table 4: Effect of maize crop residue biochar on days to flowering and fruit yield of pepper

Parameters	Day to flowering	Fruit yield (g)
Control	57.67c	1.19c
5tonha^{-1}	67.3bc	1.51b
10tonha^{-1}	67.33bc	1.83a
15tonha^{-1}	62.67c	1.56b
20tonha^{-1}	82.00a	1.81a
SE±	2.90	0.07

Means with the same letter(s) in a column are not significantly different at 5% level of probability.

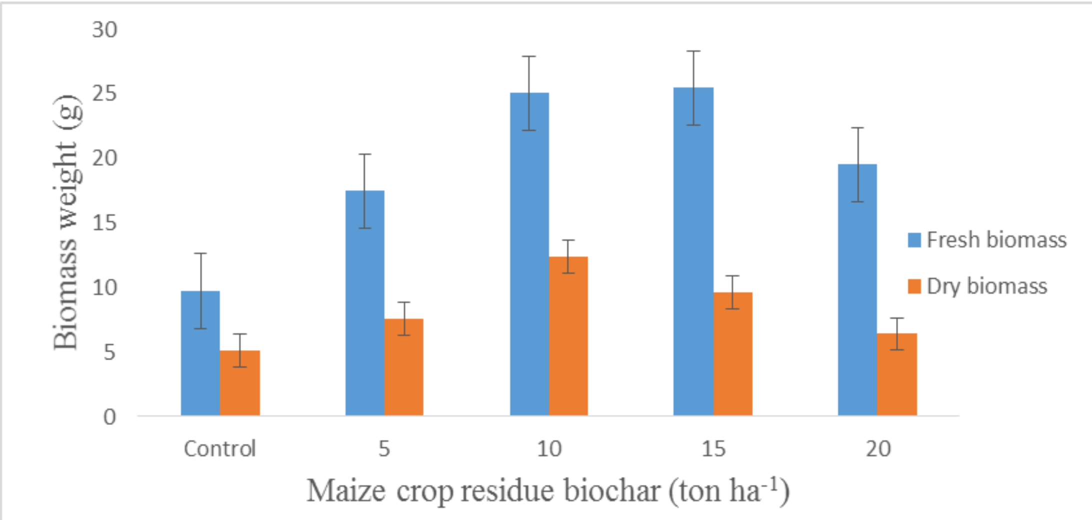

Figure1: Effect of maize crop residue biochar on biomass weight of pepper

Table 5: Effect of maize crop residue biochar on some selected soil properties

Treatment	Total Nitrogen(g kg^{-1})	Organic Carbon (g kg^{-1})	Available Phosphorous (mgkg^{-1})
Control	0.04^{a}	5.64^{b}	19.18^{b}
5tonha^{-1}	0.04^{a}	7.40^{b}	22.90^{b}
10tonha^{-1}	0.01^{a}	13.08a	22.91^{b}
15tonha^{-1}	0.05^{a}	6.95^{b}	35.79^{a}
20tonha^{-1}	0.07^{a}	6.40^{b}	14.92^{b}
SE±	0.01	0.26	2.32

Means with the same letter(S) in a column are not significantly different at 5% level of probability

Conclusion

From the results of this study, 10 ton ha^{-1} of maize crop residue biochar improved the growth, fresh biomass weight, dry biomass weight, fruit yield of pepper and organic content of the soil and therefore it can be considered useful for the cultivation of pepper in a pot experiment.

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SUB-THEME 3


ANIMAL PRODUCTION,
NUTRITION, HEALTH,
GENETIC IMPROVEMENT
AND WELFARE

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Poultry Litter Stimulates Antagonistic Microbes against Plant-Parasitic Nematodes of Cacao

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Abstract
Sudden death of cacao plants in the field and failure of seedlings to establish in rehabilitated fields have been associated with plant-parasitic nematodes. With the aim to ameliorate their adverse effects, this research was conceived to determine the effect of soil amendments with poultry litter on cacao, parasitic nematodes, soil bacteria and fungal population densities. The field experiment was set as a randomized complete block design of a 4x3 factorial arrangement with four rates of poultry litter (0, 0.2, 0.3, 0.4t/ha) and three rates of carbofuran (0, 1.25, 2.50kg a.i/ha). The growth of cacao was significantly improved by the amendments compared to the un-amended plots. Nematode population densities were negatively correlated with plant height, stem girth, leaf area and number of leaves. Bacteria species of Arthrobacter, Bacillus and Pseudomonas were the most numerous species identified from the litter amended soil, while the fungi identified included Arthrobotrys dactyloides, Aspergillus niger, A. flavus, Trichoderma harzianum, T. viride, Paecilomyces lilacinus and Verticillium chlamydosporium. Fungal and bacterial densities increased at 3, 6, 9 and 12 months after transplanting of cacao in the field in all the treatments, reaching a peak at 9 months. However, poultry litter amended plots had the greatest number of bacterial and fungal counts, while carbofuran treatments had the least. The observed significant increase in soil borne microbial populations has an essential role in nematode suppressive mechanisms.
Keywords: Theobroma cacao, poultry litter, plant-parasitic nematode, fungi and bacteria

Introduction
Cacao (*Theobroma cacao* Linnaeus) play important roles in the agricultural sector of the Nigerian economy contributing significantly to gross national product, food security, employment, diversification of income sources in rural and urban areas (Folayan *et al*., 2006). However, plant-parasitic nematodes constitute a rapid decline in adult cacao productivity and establishment of seedlings in fresh and rehabilitated fields. While chemical control can reduce the impact of nematode infestations (Afolami, 1993), effective nematicides are too expensive for resource-poor farmers and often results in a noticeable decrease of many soil biological processes, notably by suppressing predators and parasites of these nematodes, contamination of aquifers and negative shifts such as health hazards, environmental pollution and potential atmospheric ozone depletion. However, soils, especially those with a low microbial population, are more vulnerable to reinvasion of pathogens even after fumigation (Gamliel *et al*., 2000). Nematode populations might become sensitized or resistant to repeated applications of nematicides. Hence the more urgent need to develop new management tools that are environmentally and toxicologically safe. Organic soil amendment is one of those new technologies. Organic amendments primarily used for increasing agricultural productivity have been shown to have a suppressive effect on plant-parasitic nematodes (Walker, 2004). This research was conceived to determine the effect of soil

amendments with poultry litter on cacao, parasitic nematodes, soil bacteria and fungal population densities in the field. The hope is that the current level of frustration being faced by farmers through poor cacao seedlings establishment caused by plant-parasitic nematodes can be ameliorated.

Materials and Methods

Curing of Poultry Litter and Proximate Analysis

Poultry litter (poultry droppings and wood shavings) was collected from coops with good farm sanitation and air-dried. Composite samples were obtained and analysed according to standard methods.

Experimental design

The field experiment was set as a randomized complete block design of a 4x3 factorial arrangement with four rates of poultry litter (0, 0.2, 0.3, 0.4t/ha) and three rates of carbofuran (0, 1.25, 2.50kg a.i/ha). Each treatment had 3 replications. The poultry litter in the relevant treatments were incorporated into the soil by mixing the litter with the soil at planting time and again at 3, 6 and 9 months after planting, while the carbofuran treatments were applied by mixing it with soil at planting and repeated after three months around the plants. Cacao seedlings were planted at the spacing of 3x3m. The unit plot size was 31.5m^2 accommodating 8 plant stands of cacao. Normal agronomic practices were observed. Aerial growth data measured on each plant included plant height, stem girth, leaf area, number of branches and leaves.

Soil assay for nematodes

The soil was assayed to confirm the presence and population density of the nematodes. A 100g sub-sample soil was assayed for nematodes using the tray modification of Baermann technique. Identification using taxonomic keys and counting was repeated three times and mean population of nematodes per sample calculated following the various procedures for soil assayed as outlined by Coyne *et al*. (2007).

Extraction of bacteria and fungi from soil

Counts of bacteria and fungi were determined by serially plating the soil-litter suspensions and controls onto selective media in 9-cm-diameter petri dishes with a Spiral Plater. Soil (2 g) was weighed and placed into a whirlpac blender bag with 18 ml of deionized sterile water for the first dilution. Each sample then was placed in a Stomacher blender and agitated for 30 seconds. Further dilutions were made in a laminar flow hood and the suspensions were plated onto selective media for microbial enumeration. For fungal isolation, potato dextrose agar (PDA) amended with streptomycin (0.1g/liter) and tetracycline (0.01 g/liter), and PDA amended with streptomycin (0.1g/liter) and chloramphenicol (0.01 g/liter), were used. Nutrient agar with nystatin (0.05 g/liter) was used for isolating bacteria. Serial dilutions were made to 10^{-3} for fungi and 10^{-5} for bacteria. Bacterial colony forming units were counted after 3 days and fungal colony forming units were counted 4 to 5 days after incubation at 25°C in the dark. Bacteria selected for identification based on colony morphological differences were transferred to 5% trypticase soy for purification and fatty acid methyl-esters identification – FAME (Kloepper, *et al*., 1992).

Statistical analysis

Nematode population densities were $\log_{10}(x + 1)$ transformed and percentage data were square-root-transformed prior to analysis to stabilize variances (Gomez & Gomez, 1984), while the other data collected were not transformed. Only the predominant nematode species were included in the data analysis. Analyses of variance (ANOVA) were carried out to test for main effects and interactions.

Results and Discussion

The compost used in the experiments had the following composition: total nitrogen 3.24%, carbon 27.9%, C:N ratio 9.1, phosphorus 1.86%, potassium 0.05%, calcium 1.40% and magnesium 0.64%. The growth of cacao was consistently improved by the amendments compared to the un-amended plots in the field naturally infested with plant-parasitic nematodes. The poultry litter alone or combined with carbofuran-treated plots led to a significant increase in the vegetative of cacao compared to carbofuran-treated and un-amended plots (Table 1). This is in agreement with earlier reports that the addition of organic amendments to soil provides supplementary nutrients which in turn may have a positive effect on vegetative growth and yield, consequence of which the nematode damage might have markedly reduced (Van Den Boogert *et al.,* 1994, Rodriguez-Kabana *et al*., 1987).

Table 1: Effects of poultry litter and carbofuran soil amendments on the growth of cacao in the field naturally infested with plant-parasitic nematodes

Treatments	Plant height[1] (cm)	Stem girth (cm)	Number of Branches	Number of Leaves	Leaf area (cm^2)
PL at 0.4t/ha	252.3a	4.38a	33.8a	342.8a	246.3a
PL at 0.4t/ha + C at 2.50kg a.i./ha	252.7a	4.39a	32.3a	341.7a	246.7a
PL at 0.4t/ha + C at 1.25kg a.i./ha	253.3a	4.39a	32.8a	340.8a	246.3a
PL at 0.3t/ha	228.7c	3.98c	24.3b	256.3b	224.3b
PL at 0.3t/ha + C at 2.50kg a.i./ha	234.0b	4.03b	24.3b	257.0b	224.3b
PL at 0.3t/ha + C at 1.25kg a.i./ha	234.7b	4.05b	25.0b	257.0b	224.7b
PL at 0.2t/ha	157.0d	3.15d	19.7c	154.0c	143.7c
PL at 0.2t/ha + C at 2.50kg a.i./ha	155.3d	3.17d	19.7c	152.3c	143.7c
PL at 0.2t/ha + C at 1.25kg a.i./ha	155.3d	3.12d	19.7c	152.7c	143.3c
C at 2.50kg a.i./ha	131.7e	2.90e	12.0d	105.0d	120.3d
C at 1.25kg a.i./ha	101.3f	2.10f	6.8e	67.3e	91.7e
Control (no amendments)	79.7g	1.81g	4.3f	44.0f	66.7f

PL = Poultry litter; C = Carbofuran. [1]Means followed by the same letter in the same column do not differ significantly according to Fisher's LSD test (5%)

In contrast, plant-parasitic nematodes reduced the plant height, stem girth, number of branches and leaves, and leaf area of cacao in un-amended plots. The increase in growth parameters in nematicide treated plots attested to this fact. In the same vein, relationships between nematode population densities and vegetative growth of cacao revealed various statistically significant interactions (Table 2). *Meloidogyne incognita* population density was negatively correlated with plant height ($r = -0.63$, $P \leq 0.001$), stem girth ($r = -0.51$, $P \leq 0.001$), leaf area ($r = -0.86$, $P \leq 0.001$) and number of leaves ($r = -0.81$, $P \leq 0.001$). Similar relationships were observed for the other major nematodes associate with cacao (Table 2).

Table 2: Linear correlation matrix (half) of mean values for nematode population densities/100g soil, height, stem girth, leaf area, number of branches and number of leaves of cacao

	Hm	Pc	Rs	Height	Stem girth(cm)	Leaf area (cm^2)	Number of branches	Number of leaves
M. incognita (J2)	0.76***	0.43*	0.59***	-0.63***	-0.51***	-0.86***	0.04	-0.81***
H. multicinctus	-	0.46**	0.72***	-0.59***	-0.49**	-0.89***	0.07	-0.78***
P. coffeae		-	0.84***	-0.03	-0.25	-0.79***	-0.09	-0.77***
R. similis			-	-0.16	-0.28	-0.84***	-0.34*	-0.80***
Height (cm)				-	0.87***	0.83***	0.04	0.67***
Stem girth (cm)					-	0.98***	-0.07	0.69***
Leaf area (cm^2)						-	-0.15	0.60***
Number of branches							-	0.80***

Hm: *Helicotylenchus multicinctus*; Pc: *Pratylenchus coffeae*; Rs: *Radopholus similis*.
*,**,*** = correlation coefficient significant at P ≤ 0.05, 0.01 or 0.001, respectively

Bacteria identified from the litter amended soil included *Arthrobacter globiformis, A. ilicis, A. pascens, Bacillus macerans, B. thuringiensis, Cellulomonas fimi*, *Pasteuria penetrans*, *Pseudomonas fluorescens, P. corrugata and P. vesicularis*. Species of *Arthrobacter, Bacillus* and *Pseudomonas* were the most numerous species identified. Fungi identified included *Arthrobotrys dactyloides, Aspergillus niger, A. flavus, Trichoderma harzianum, T. viride*, *Paecilomyces lilacinus* and *Verticillium chlamydosporium*. Fungal and bacterial densities increased at 3, 6, 9 and 12 months after transplanting of cacao in the field in all the treatments, reaching a peak at 9 months (Table 3). However, poultry litter amended plots had the greatest number of bacterial and fungal counts, while carbofuran treatments had the least. This result was consistent with earlier reports that amending the soil with a low C:N ratio (less than 20:1) substrate resulted in abundance of enrichment-opportunist antagonistic microbes (Ferris & Matute, 2003; Wang *et al*., 2004, 2006) and rapid mineralization of N in the form of NH4+ or NO3- for absorption and uptake by plant roots. The poultry litter used in this experiment has a low C:N ratio (9:1) and this resulted in the suppression of nematode population on cacao. With increase in microbial diversity and numbers, it becomes more likely that bacteria and fungi capable of parasitizing specific nematode life stages or producing substances toxic to nematodes may be involved in the resulting nematode control (Sikora *et al*., 2007; Uambano & Kerry, 2007; Siddiqui & Akhtar, 2009). Bacteria and fungi identified from the litter amended plots were species that have commonly been found in soil. Bacteria are quite diverse in nutritional requirements, and several species identified in the genera *Arthrobacter, Bacillus and Cellulomonas* have the ability to use ammonium salts or nitrates as their sole source of nitrogen. Poultry litter has high levels of nitrogen in the organic and inorganic forms (Edwards & Daniel, 1992; Sims & Wolf, 1994) that would be readily available to these organisms. Bacteria, such as *B. macerans*, use ammonia to fix N2 under anaerobic conditions (Edwards & Daniel, 1992). In addition, the genus *Cellulomonas* has been isolated from substrates high in cellulose and has the ability to reduce nitrate to nitrite (Edwards & Daniel, 1992). Chicken litter is composed of poultry droppings and saw dust (Gullino *et al*., 2003), which would provide both cellulose and nitrogen to *Cellulomonas* spp.

Conclusion

Relationships between plant-parasitic nematodes, the soil environment, organic amendments and plant host health are obviously complex and make it difficult to assess the activities occurring in soil. However, use of poultry litter as soil amendment has been shown in this experiment to reduce plant-parasitic nematode infection on cacao. The observed increase in soil borne microbial populations have an essential role in nematode suppressive mechanisms. More detailed studies of microbial population dynamics in litter-amended soils are needed to identify the specific roles that fungi and bacteria may have in nematode control.

Table 3: Effects of soil amendments on microbial population densities at 3, 6, 9 and 12 months after transplanting of cacao in the field

Treatments*	3 months† [1]	6 months	9 months	12 months
	Fungi[a] Bacteria[b]	Fungi Bacteria	Fungi Bacteria	Fungi Bacteria
PL at 0.4t/ha	125.7a 201.1a	144.7a	153.1a	139.1a
PL at 0.4t/ha + C at 2.50kg	106.3c 153.3b	216.3a	233.4a	233.7a
a.i./ha	107.0c 154.2b	111.2b	113.3b	110.3b
PL at 0.4t/ha + C at 1.25kg	125.4a 200.9a	162.5b	161.7b	163.1b
a.i./ha	105.7c 152.8b	111.4b	113.5b	110.7b
PL at 0.3t/ha	106.1c 154.1b	161.9b	162.1b	162.9b
PL at 0.3t/ha + C at 2.50kg	119.0b	143.3a	152.9a	138.7a
a.i./ha	200.6a	216.1a	232.7a	233.2a
PL at 0.3t/ha + C at 1.25kg	105.7c 153.7b	112.1b	112.7b	110.3b
a.i./ha	106.2c 153.4b	162.3b	162.3b	163.5b
PL at 0.2t/ha	71.7e 86.3d	110.5b	113.1b	110.5b
PL at 0.2t/ha + C at 2.50kg	71.5e 86.3d	162.1b	161.9b	162.7b
a.i./ha	89.3d 101.1c	143.7a	153.4a	138.9a
PL at 0.2t/ha + C at 1.25kg		216.7a	233.1a	232.9a
a.i./ha		112.3b	113.3b	110.4b
C at 2.50kg a.i./ha		162.6b	161.8b	163.3b
C at 1.25kg a.i./ha		112.9b	112.9b	110.3b
Control (no amendments)		162.2b	162.2b	163.1b
		77.1d	81.8c	82.3c 100.7c
		96.3d	100.3c	82.7c 101.2c
		77.3d	82.1c	110.7b
		96.1d	100.7c	162.9b
		101.2c	112.8b	
		145.7c	162.1b	

PL: Poultry Litter; C: Carbofuran. †Analysis undertaken on transformed data [$\log_{10}(x+1)$], back-converted means shown. [1]Means followed by the same letter in the same column do not differ significantly according to Fisher's LSD test (5%). [a]: Fungal counts x 10^3 CFU per gram of soil. [b]: Bacterial counts x 10^5 CFU per gram of soil

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Effect of Dietary Inclusion of Tannin on Haematology and Serum Biochemical Parameters of Growing Lambs

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Abstract
The aim of this study was to determine the effect of dietary inclusion of Acacia tannin extract, ATE on the haematology and serum biochemical parameters of growing Merino lambs. Twenty four lambs were allocated in randomised complete block design into 4 dietary treatments and fed a TMR diet containing with T1, urea-based diet, T2, urea-TMR+46 g/kg tannin extract, T3, calcium nitrate-based TMR, T4, calcium nitrate-based TMR+46 g/kg tannin extract. Feeding lasted for 81 d, consisting of 21 d for gradual adaptation of the sheep and 60 d growth period. At the experiment, 5 mL of blood was collected from each animal via jugular vein to determine haematological profile and serum biochemical variables. Data obtained was analysed using the GLM procedure of SAS and treatment means separated with Tukey's test. No clinical or sub-clinical signs of morbidity and tannin intoxication symptoms were observed across the treatments. Animals on nitrate-based TMR had higher haematocrit, RBC count and haemoglobin concentration than animals on urea-based TMR. Similarly, ATE reduced plasma LDH and cholesterol concentration. Although there was slightly elevated BUN levels across the treatments, levels of creatinine, total protein, ALT, AST and LDH levels were within normal reference range. The result suggests that Acacia tannin extract could be added at current dose (46 g/ kg DM) to diets of animals without any serous negative consequences.

Introduction
The restriction on the use of antibiotics as dietary supplement across the EU has elicited wide interest in the use of plant secondary metabolites in sustainable animal production activities (Akanmu and Hassan, 2017; Patra and Yu (2014). These plant secondary metabolites (Phytochemicals) have wide biological activity and hence wide application in ruminant production. As a dietary additive, their utilisation continue to generate much interest especially in their ability to help increase bypass protein flow to the small intestine, control of bloat and intestinal nematode, as well as methane mitigation (Patra and Saxena, 2010). Urea is widely included in the diets of ruminants to serve as a cheap source of non-protein nitrogen (NPN) utilisable by rumen microbes for microbial protein synthesis through which ruminants can derive nutrient (Adejoro and Hassen, 2017). However, there is a growing interest in the use of nitrate salts due to its potential in mitigating enteric methane, apart from also being an NPN source (Adejoro and Hassen, 2018). Condensed tannins, though not digestible by the animals, may have significant effect on the physiological state of the animals (Makkar and Singh, 1995). Most of the studies on tannin and nitrogen interaction in ruminants have focused on protein digestibility and growth performance, while their impact on the physiology and health status of animals have not been widely reported while opportunities for nitrate use in ruminant needs to be explored further (Adejoro, ibid). Not only can high blood ammonia concentration alter hepatic

metabolism, by increasing ureagenesis and glucose metabolism in the liver and other tissues (Taylor et al., 2009), it can elicit serious effects on growth, as well as on the quality of animal products such as milk, and meat. On the other hand, high dietary tannin inclusion may have significant effect on the immune status of growing lambs and meat quality (Priolo et al., 2000). Haematological parameters as well as serum indices are reliable tools to evaluate the immune status and systemic toxicity in animals, especially serum enzymes which are known to be sensitive indicators of liver or kidney damage (Silanikore et al., 1996). Therefore, this study was designed, to evaluate the haematology and serum biochemical parameters of growing lambs receiving tannin extract supplementation.

Materials and Methods

The experiment was conducted at the small stock unit of the University of Pretoria, Pretoria, South Africa. The experiment was designed as a randomised complete block design. Forty weaner sheep (24 ram-lambs and 16 ewe-lambs) were blocked based on sex and body weight and then allocated to four dietary treatment Six male and four female animals were therefore allocated to each dietary treatment, comprising a total mix ration containing urea or calcium nitrate with or without tannin extract. Tannin extract was included at 46 g/kg feed DM. Animals were fed the respective diets for a total period of 81days comprising of an initial 21days of gradual adaptation of the sheep to the experimental diets, and 60days of continuous feeding and monitoring of growth performance. At the end of the 81 d, 5 ml blood samples were drawn from the jugular vein of each animal into separate serum bottles, for the analysis of serum biochemical and haematological parameters.

Statistical analysis

Data was analysed using the GLM procedure of SAS (SAS Inst. Inc.; Cary, NC, USA). Treatment means were compared using Tukey's test and reported as least significant means and standard error of means. Significant differences were declared when $P < 0.05$.

Table 1: Ingredients and composition of experimental diet

Ingredient	**Urea only**	**Urea + tannin**	**Nitrate only**	**Nitrate+ tannin**
Sunflower meal	16.8	16.1	17.1	16.4
Fine milled maize	27.6	26.4	28.2	27.0
Wheat bran	4.9	4.7	3.4	3.3
Molasses	5.9	5.7	5.1	4.9
Lucerne meal	19.70	18.9	19.0	18.2
Eragrotis hay	23.2	22.2	23.1	22.1
Urea	1.0	1.0	0	0
Coarse salt	0.5	0.5	0.50	0.5
Premix[1]	0.4	0.4	0.40	0.4
Nitrate Source[2]	0	0	3.2	3.1
Tannin extract[3]	0	4.2	0	4.2
	100	100	100	100
Analysed composition				
Dry matter, g/kg	912	909	910	910
Organic matter, g/kg DM	930	934	920	923
CP, g/kg DM	213.8	209.4	188.5	183.9
NDF, g/kg DM	333.7	364.4	377.0	354.0
ADF, g/kg DM	196.1	218.9	215.3	195.4

Results and Discussion

Tannin inclusion did not seem to have a significant effect on most of the haematological parameters. Only slight reduction in MCV, coupled with slight increase in RBC distribution width and monocyte count could be associated with tannin inclusion compared to animals without tannin (P=0.08). The result of the serum biochemistry analysis on experimental animals is shown in Table 3. The interaction effect of nitrogen source and tannin inclusion was significant (P=0.05) in blood urea nitrogen (BUN). Tannin inclusion did not have any significant effect on total serum protein, albumin and globulin concentrations in the plasma of the experimental animals. Tannin inclusion significantly affected plasma cholesterol concentrations in the experimental animals (P=0.03). Tannin inclusion did not show any significant effect on BUN or creatinine concentration of experimental animals. Neither nitrogen source, nor tannin inclusion had any significant effect on total serum protein, albumin and globulin concentrations in the plasma of the experimental animals. Tannin inclusion significantly affected plasma cholesterol concentrations in the experimental animals (P=0.03). Lambs on urea+tannin and nitrate+tannin diets had lower cholesterol concentration than animals on urea only and nitrate only diets. Nitrogen source and tannin inclusion did not show any significant effect on Aspartate amino-transferase and Alkaline phosphatase concentrations in the blood of the experimental animals. However, nitrogen source significantly affected Alanine amino-transferase, with elevated concentrations in animals feeding on nitrate diets as compared to animals feeding on urea diet. Similarly, tannin inclusion significantly reduced lactate dehydrogenase concentration in the animals feeding on urea+tannin and nitrate+tannin as compared to the urea only and nitrate only diets.

Table 2: Effect of acacia tannin extract supplementation on growing lambs supplemented consuming a total mixed ration on haematological parameters

	Urea diet		**Nitrate diet**					
Parameter	**No tannin**	**With tannin**	**No tannin**	**With tannin**	**SEM[1]**	***P*-values**		
Haemoglobin (g/L)	116.9	119.9	122.5	125.0	1.79	0.09	0.629	0.88
RBC count ($\times 10^{12}$ cells/L)	9.97	10.6	10.6	10.8	0.17	0.09	0.348	0.50
Haematocrit (L/L)	0.33	0.34	0.35	0.34	0.01	0.08	0.877	0.36
MCV (fL)	33.1	32.1	33.2	32.1	0.27	0.869	0.08	0.82
MCH (pg)	11.8	11.4	11.6	11.6	0.09	0.716	0.279	0.26
MCHC (g/dL)	35.6	35.4	34.8	36.2	0.26	0.833	0.341	0.15
RBC Distr. Width (%)	17.3	17.4	16.7	17.8	0.19	0.589	0.08	0.48
WBC count ($\times 10^{9}$ cells/L)	7.56	7.46	7.11	7.43	0.23	0.721	0.668	0.94

[1]SEM, standard error of mean. N, effect of nitrogen source. T, effect of tannin inclusion. NT, interaction effect of nitrogen source and tannin inclusion

Table 3: Effect of acacia tannin extract supplementation on growing lambs supplemented consuming a total mixed ration on serum biochemical parameters

	Urea diet		Nitrate diet					
Parameter	**No tannin**	**With tannin**	**No tannin**	**With tannin**	**SEM[1]**	**P-value**		
n	**10**	**10**	**10**	**10**		**N**	**T**	**NT**
BUN, mmol/L	8.79[b]	9.09[ab]	10.2[a]	8.89[ab]	0.18	0.02	0.13	0.05
Creatinine, µmol/L	57.9[b]	58.0[b]	67.3[a]	65.1[ab]	1.23	0.05	0.69	0.51
Blood Glucose, mmol/L	4.57[a]	3.77[ab]	4.30[ab]	3.60[b]	0.13	0.83	0.01	0.93
Total serum protein, g/L	62.9	60.5	63.1	62.1	0.48	0.76	0.27	0.54
Albumin, g/L	35.6	35.7	37.6	37.6	0.39	0.29	0.78	0.79
Globulin, g/L	27.3	24.8	25.6	24.5	0.52	0.31	0.24	0.47
Cholesterol, mmol/L	1.34[ab]	1.10[b]	1.41[a]	1.31[ab]	0.04	0.82	0.03	0.43
Alkaline phosphatase, U/L	297.2	273.0	302.8	274.6	14.8	0.87	0.91	0.84
Alanine amino-transferase, U/L	14.0[b]	15.6[ab]	17.9[a]	18.8[a]	0.58	0.001	0.35	0.56
Lactate dehydrogenase, U/L	917.8[a]	805.9[b]	946.3[a]	872.1[ab]	18.6	0.88	0.01	0.77
Total triglyceride, mmol/L	0.229	0.246	0.217	0.217	0.01	0.90	0.62	0.69

[1]SEM, standard error of mean. N, effect of nitrogen source. T, effect of tannin inclusion. NT, interaction effect of nitrogen source and tannin inclusion

There was no obvious sign of disease condition in the experimental animals such as scouring, diarrhoea, anorexia, bloat or anaemia. Most of the haematological parameters were within the normal reference range for ovine species. Significant elevation of Hb, and RBC count associated with nitrate supplementation reported in this study is consistent with the report of El-Zaiat et al, (2014) on nitrate supplementation. Increased Hb and RBC count in animals consuming nitrate diets can be associated with a physiological response to mitigate the effect of nitrite on the oxygen-carrying capacity of the blood by increasing the cell numbers to meet reduced capacity. It is widely believed that condensed tannins are not absorbed into portal circulation (Terrol et al., 1994). However, the presence of other phenolics in the plant extract may instigate symptoms other than those associated with CT. Haemogblobin (Hb) is the iron-containing conjugated protein that transport oxygen and carbon dioxide across cells and tissues in the body. The high BUN in this study correlates with high plasma glucose concentration across the treatments although tannin inclusion led to a reduction in glucose concentration. This result agrees with the observation of Taylor-Edwards et al., (2009) who noted that high BUN is usually associated with high serum glucose concentration and occurs as a result of either a reduction in glucose utilization rate, increased net hepatic glucose production or overall increase in hepatic glycogenolysis. BUN have a linear relationship with total N-excretion rate and therefore lack of differences in BUN is an indication that hepatic activity may not impaired (Kohn et al., 2005). BUN and creatinine are indicators of kidney functionality in animals (Olafadehen, 2011). Total serum protein, albumin and globulin, though not significantly different across the treatments, are indicators of the protein status of the animals (Kaneko, 1989). It is unclear what factors could lead to the generally slightly higher ALP levels in the experimental animals compared to the reference values but age of animals have been observed to significantly affect ALP concentrations (Lepherd, 2009), with younger animals usually having higher ALP concentration in their blood. While higher LDH concentration was reported in cattle fed the leaves of tannin-containing oak (Garg et al., 1992), lower LDH concentration in animals feeding on tannin was observed in the current study as compared to the animals without tannin. This may be due to the nature of tannins-hydrolysable tannin versus condensed tannin. The stepwise introduction of the diets and gradual adaptation allows the rumen microbes to stimulate adequate production of nitrate and nitrite reducing bacteria thus reducing the animal's susceptibility to any clinical or sub clinical intoxication (Leng, 2000). These may have also played a significant role in ensuring that the physiological wellbeing of the animals was sustained throughout the experiment.

Conclusion

No clinical or sub-clinical signs of morbidity and tannin intoxication were observed in the parameters evaluated. Slight increase in haemoglobin, haematocrit and RBC count was associated with the use of calcium nitrate instead of urea as an NPN source. Acacia tannin extract and either of urea or calcium nitrate, at the current dose can be fed to growing lambs, without any serous negative consequences.

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Grasscutter Multiplication and Domestication in Post-Ebola Era: Reassessment of its Prospects and Challenges in Nigeria

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Abstract
Nigeria is the most populous nation in Africa, with enormous biodiversity. Nigerians relish eating bushmeat, there is practically no ecological zone in Nigeria where bush meat is not consumed. Tropical countries are blessed with several rodent species, they are highly esteemed and an essential income and food protein source for local inhabitants. Especially, cane rat is seen throughout sub-Saharan Africa; its flesh is very popular for domestic consumers. In countries like Nigeria, Ghana, Ivory Coast, Benin, and Togo including some Central African countries, its domestication has been successful. Ebola had come and go, but Nigerians are left with the after effect of the experience. Post Ebola era, an era where the afterwards effect of the disease is felt. This era is characterized by low demand for bush meat, although the trend may reduce as time goes on. Unfortunately, this is the era where grasscutter domestication is tipped to be a tool for poverty reduction and to reduce unemployment in the country. Researchers and civil society organizations have front the advantages of grasscutter domestication and multiplication, but all effort seems to produce little result since low patronage were recorded. Therefore, there is need to revisit the prospects involved and also access the various challenges hindering the success of grasscutter farming in Nigeria.
Key words: Grasscutter, Ebola, Nigeria, Multiplication and Domestication

Introduction

Thryonomys swinderianus, known as Grasscutter or greater cane rat is a Non timber forest product (NTFP) that is tropical in distribution (Unaeze, 2016). Being a non-timber forest product, its contribution to livelihood of rural communities is enormous. Cane rat is found in the tropical forest of Africa. The animal commonly lives among dense grasses mostly along river banks and swamps and are rampant among herbaceous vegetation where there is a good cover. They do not dig burrows like other rats but they hide in holes and scrape a small saucer- shaped depression among the vegetation (Aluko *et al*, 2015). Despite their large size, they run quick and they are known to be good swimmers, living most of their time in burrows and others at ground level. The climatic situation in Nigeria helps them to acclimatize into so many habitats and forests alike. In suitable habitats their presence are commonly known with the 45^{o} cut on the grass stem or by their characteristic feacal pellets scattered on the ground (Aluko *et al*, 2015).In Nigeria, Cane rats contribute to the protein source, provide income and assist poverty reduction of local inhabitants. It is not only eaten in Nigeria it is a choice meat to many households in sub- Sahara Africa. Experts reported the potential importance inherent in domesticated Grasscutter in West Africa (Asibey 1979; Baptist and Mensa 1986; Adedapo and Adekunle 2013). Reports in literatures also show some level of successes in domestication of Grasscutter in Ghana, Benin and Nigeria (Adedapo and Adekunle, 2013).Its meat is believed to look like that of a piglets and its price costs more than a kilogram of chicken, beef, pork or lamb. Its taste, toughness in skin and size also makes it easily acceptable (Adedapo and Adekunle, 2013).Cane rat in captive is reported to be human friendly and its odour is less unfriendly (Benjamin *et al,* 2006). The Ebola disease outbreak in West Africa has been the largest in the history of the disease since its first case in 1976 (Mafunda *et al,* 2016). At the height of the year 2013, Ebola crises hit Africa, and were declared in Nigeria by the Federal Ministry of Health on 24th July, 2014 which marks the inception of Ebola era in Nigeria. On September 23rd, 2014 the federal ministry of health reported a total of 19 confirmed cases, 15 were from Lagos while four cases were reported in Rivers State. A total of 7 deaths were recorded accounting for 40 percent case mortality rate .It had been reported that transmission of EVD to human occurs through contact with dead or living infected animals such as primates (UNICEF, 2014). Pigott *et al,* (2014) summarized the information on ebola virus infection on animals in scientific literature. Stating that species implicated are gorillas (*Gorilla gorilla*), chimpanzees (*Pan troglodytes*), Old World fruit bats (*Epomops franqueti, Hypsignathus monstrosus, Myonycteris torquata, Epomophorus gambianus, Eidolon helvum*) and duikers (*Cephalophus* spp.). Fruit bats were the only species in which the virus was detected (by polymerase chain reaction-PCR) in live animals, and remain the most likely, but still unconfirmed, natural reservoir host for EBV (EFSA, 2014). Despite the yet to be claimed epizootic nature of the disease, news making round was that Ebola was transmitted by bat. Subsequently the widespread of the news resulted into viral information on how the virus supposedly emanates from bushmeat. Consequently, policy and announcement were made on different media and forums that bushmeat were ban from consumption (Ndem *et al*, 2015). This mindset was stamped into the subconscious of many people and negatively affects the marketability and productivity across the bushmeat value chain. 2015 till present (post Ebola era), evidence of this effects were still felt in present times. Bush meat dealers reportedly ran out of business because consumers refuse to patronize them due to fear of contacting Ebola virus (Ese *et al*, 2015). Also, the fear of Ebola negatively affects anyone who had it in mind to start a bushmeat business. Unfortunately, this is an era where Grasscutter is perceived to be a future livestock to provide income and protein to rural and urban settlements that relish bushmeat. In spite the enormous potential in cane rat farming, its acceptance by farmers and its consumers maybe low compared to other established domesticated animals, therefore there is need to explore the prospect and challenges in an era where the fear of Ebola and other zoonotic diseases affects the marketability and meat value of wild and domesticated animals alike.

Ebola and its impact in Nigeria

Pre-Ebola Era

The inception of bushmeat consumption by man can be traced to man's history and marks the beginning of pre-Ebola era; the era ends immediately Ebola virus was announced in Nigeria. This era is characterized by high interest in bush meat consumption and wild animal utilization such as for ethno medicinal purposes. Ajayi (1971) reported that wild animal consumption among rural people in Nigeria's rainforest was 20% of their total animal protein intake compared to the 13% for the whole country. In this era there was little fear or awareness of contacting any disease by eating bush meat. This may be due to little research discoveries along that area. Adeola (1987) reported that 80% or more of the population would eat bush meat irrespective of their ecological zone, tribe or culture. There is low supply of bush meat as oppose to the demand because of the high rate of consumption. In this period, many tribal areas in Nigeria were heavily mounting pressure on wildlife resources and it was feared as at that time that the state of unorganized and uncontrolled exploitation could diminish the remaining game stock rapidly to an unsustainable level. Due to this, fear of extinction grips the mind of advocates of conservation, therefore in this era many conservation measures were established. Among these measures is livestock domestication. This is believed to ease the pressure on the animals in the wild. This era gave birth to the successful domestication of cane rats in West Africa.

Ebola Era

Ebola virus hit Nigeria on July 24th 2014 as declared by the federal government ministry of health and ended 24th September, 2014. Handling and consumption of bushmeat may thus increase a person's risk to fall ill from the disease (Isabel *et al*, 2017).The EVD outbreak has a much wider impact on food security, linked to the effects of measures taken to limit the transmission of the virus. The diseases affect food availability and accessibility (Olawale *et al*, 2016). The resultant effect shows that many households in rural communities whose livelihood depends on bushmeat could not meet up to the feeding and financial needs of their households, thereby depend on cheaper food with less quality nutrients such as cassava with little or no protein sources. This era is characterized by surplus supply but low demand for bush meat, marking the lowest point of bushmeat sales in the history of the nation. Consequently, many bushmeat business owners completely fold up. This trend continued during and immediately after the outbreak. Media played some roles in spreading the news, therefore helping in bushmeat perception shift. The assumption is that even when bushmeat is touched they can easily contact the deadly virus.

Post Ebola Era
This era began immediately Nigeria is declared free from Ebola virus. At the inception of this era, the sale of bushmeat was still affected by the just curtailed Ebola virus. A year after the outbreak, Oyediran *et al,*(2015) stated that before the EVD outbreak, 37.14% of the respondents had more than 50 customers while patronage reduced to less than 25 (50%) customers in a day after EVD outbreak. Similarly, 42% of respondents had more than ₦21,000 in a day before EVD outbreak as against less than ₦5,000 in a day after the outbreak. The implication of this is that the return gotten from bush meat businesses may have reduced due to the outbreak. Therefore, in the post-Ebola era, there are lower sales of bushmeat than the pre-Ebola era. Also the beginning of this era is saddle with lower bushmeat patronage but this trend may reduce overtime. In a survey conducted after Ebola outbreak, 85.5% of the respondents were wary of the Ebola virus irrespective of their educational, revealing that people are still conscious about the disease. World wildlife fund (WWF, 2014) reported that in spite of the pre scare of Ebola, hunting of wild animals for bushmeat business is still going on significantly in parts of Nigeria. Evidently, on March 29, 2016, an estimated 10,000 local hunters from the northeast of Nigeria gathered in Adamawa state for annual oath taking festival, the festival witness a large amount of fish killed. This era is also characterized by increase awareness by researchers and consumers of bushmeat on different zoonotic diseases.

Grasscutter multiplication and domestication in Nigeria

Grasscutter is locally known as OYA in Yoruba land, NCHI in Igbo land, the Urobo or Isokos calls it UDI, the Ijaws call it IKIRI and IZAY by the Igbirras, EVUATOR by the Benin's, EMI in Igala land and UNAM-UKOT by the Efiks/Ibibios. Animals are often domesticated for many reasons, according to Zeder (2012), over the past 11,000 years; wild animals are domesticated as livestock, working animals, household pets, and companions. The directions that different animal species followed into domestication are remarkably different, shaped by biological constraints and opportunities that the animals brought into domestication, as well as by the different cultural contexts of their human partners. Several reasons were reported by researcher for domesticating Grasscutter, some believed that the meat provide protein supplementation and income generation (Benjamin *et al,* 2006; Yeboah, 2009), others believed domesticated animals are alternative to poached animals (Zeder,2012: Ijeomah *et al,*2016). Cane rat have two species belonging to the genus *Thryonomys*. These are: *Thryonomys swinderianus* known as greater Cane rats which are found in Africa South Sahara, and *Thryonomys gregorianus* known as lesser cane rats found in Cameroon, Southern Sudan, and Zimbabwe (Okarafor *et al,* 2012).The native giant grasscutter, *Thrynonomys sinderianus*, is a bushmeat species that is a prime candidate for commercial farming given its size, habitat preferences, high market price, and current consumption rate (Menz, 2014). Nigerians consume only about a quarter of the minimum daily animal protein requirement which is on the low side (Abulude, 2007). Its domestication is being encouraged in West Africa to help address the problems of exploitation through aggressive hunting, provide alternative source of income for farmers and increase farmers' access to and utilization of animal protein for dietary needs.

Prospects of grasscutter multiplication and domestication
Meat quality
Grasscutter domestication generally has been tipped as an agent for economic development and to reduce unemployment (Aluko *et al*, 2015). But the Nigerian populace is yet to explore the benefit of Grasscutter farming. Grasscutter (*Thryonomys swinderianus*) is an important source of meat and is acknowledged to be the preferred meat virtually throughout West African Sub-Region, thereby opening doors for potential exportations if adequately processed and packaged. The meat of Grasscutter is of higher price per kilogram weight than chicken, beef, pork, mutton or chevon among many West Africans and elsewhere (Adu *et al*, 2017). The meat bone ratio of grasscutter meat is higher than that of beef. Compared to other meats such as rabbit meat, Grasscutter meat is very low in cholesterol and high in protein, evidently, it is high in mineral such as iron, calcium and phosphorous (Adu*et al*, 2017), suggesting that it can serve as protein supplement for Africans. Also The economic return on rearing is comparable to that of a cow, much higher than most livestock species, and only lower than that of the pig (Adu*et al*, 2017).Meat fat content of Grasscutter include many types of lipids, but has triglycerides as the main components, phospholipids and cholesterol, with the phospholipids component being relatively constant compared to the triglycerides and cholesterol (Hernández and Gondret, 2006). Often people claims that there are different in nutrient content and palatability between the meat of grasscutter reared in the wild compared with the domesticated, result from the research by Asuk *et al*, (2017) reveals that the meat crude protein, calcium, phosphorus, iron content were higher in the grasscutter caught in the wild. Also, wild grasscutter meat was reported to be more palatable than the captive one. Therefore, nutritional quality of the feed should be improved upon in other to balance up the meat nutrient and increase the palatability of the meat.

Ethno-medicinal uses
Grasscutter plays an important role in traditional African medicine for preparation of concoctions for fertility. The hair of the animal is used to season food just as much as its stomach and intestine contents. The pancreas of the grasscutter contains a high concentration of insulin which is used for local preparation for the treatment of diabetes (Bello *et al*, 2012; Aluko *et al*, 2015). Organs such as brains, blood, urine and others can be used to produce some medicines, intact grasscutter faeces is reportedly used has enema to prevent weight lost.

Economic Prospects
Thryonomys species are intensively hunted and domesticated as an important source of protein in Nigeria and west Africa. it has been ascertained that grasscutter contributes to both local and export earnings (Bello *et al*, 2012). Olayemi, (2012)it is estimated that 80million are harvested annually, equaling 300,000 metric tons of meat in west Africa. To increase meat availability, cane rats have been domesticated and efforts have been made by government and civil societies to increase production and marketability. An increase in number of animals from 35 to 243 before sales is about 600% increase within a period of one year (Ijeomah *et al*, 2016). Ijeomah *et al*, (2016) also revealed that good management is key to the marketability of grasscutter business. For instance, cane rats are sold in families of 5 (that is one male and four females) in Songhai (Ijeomah *et al*, 2016), One family is sold for ₦45,000 while a single male adult is sold for ₦4,500 (3kg). Synchronizing the breeding ensures that many breed in a month assists the management of Songhai farm to provide many families in a month. This is done as an attempt to satisfy buyers who will need many families of same or close age range. This enables the farm to generate revenue in bulk. For instance, selling of 40 families (at the rate of ₦ 45,000) and 16 males adult in April, 2015 generated a total of ₦1,872,000 for the farm. The high breeding rate and huge profit made from grasscutter in Songhai farms ensures that if proper management is put in place there is high prospect for grasscutter farming and marketing in Nigeria. In addition, Benjamin *et al*, (2006) conducted a break-even analysis of scale grasscutter farms in Ibadan Oyo state Nigeria; he found that with

improved management skills, a small scale farm could break even after the fourth year in business or earlier.

Conservation Prospect

Unsustainable poaching of wild animal for bushmeat and other uses is endemic in Africa. This has caused some animals to go into extinction and to others their population is greatly threatened. Some methods have shown prospect reducing this trend, among which is domestication of wildlife in captive. Although grasscutter population is categorized among the least concern status on the IUCN red list, grasscutter domestication will help to reduce pressure on the population of the animal in the wild. Other advantage of keeping this animal in the wild includes helping to reduce zoonotic disease from the wild. Continued hunting of bush animals with dogs and bush burning have environmental consequences of which continued domestication will help in reducing (Opara, 2010). In contrast as oppose to many reports in literature, a scarce presence of a particular bush meat in the market does not depict the true population in the wild. In fact when large mammals are heavily harvested and it becomes much more difficult to hunt them, there is a shift of sold animals from preferred marketable large-bodied species with low reproduction rate, to smaller-bodied species with higher rate of reproduction. Overall, this shift has been interpreted as an indication that the harvesting is unsustainable.

Challenges of domesticating wildlife

Grasscutter as being put forward as a model animal for poverty alleviation in Nigeria, despite its enormous advantages, there are some challenges that is needed to overcome. Insufficient information on basic production parameters such as the animal's biology has translated into poor productivity (Adu *et al*, 2017). Benjamin *et al,* (2006) highlighted the following as the major constraints in grasscutter domestication in Ibadan ;high initial capital, stock procurement, time constraint, inadequate medical attendant, disagreement with landlords over space to rear grass-cutter and inadequate follow-up by extension services(Benjamin *et al*, 2006). Ogunjobi and Inah, (2008) ranked the constraints from the most severe to least as follows; lack of capital, insufficient feed, disease, housing, lack of enough land, handling and lack of knowledge of rearing grass-cutter. Other challenges of grass-cutter include irregular stock supply, environmental issues, processing and marketing, feeding, producer's training and education, infrastructure development, poor information dissemination and disease/mortality. However, survival of grasscutter in captives depends on solving the following issues;

Reproductive competency

For survival there is need to produce, grasscutter often do this excellently in the wild to maintain its population in a particular ecosystem judging by the IUCN ranking, however under captivity, productivity is judged by how many offerings they hence there is tendency to want them produce more than when they are in their natural environment. Currently, mating of grasscutter is natural under captivity and may cause injury or even mortality to the females. Artificial insemination as being proposed to be an alternative, but it requires harmonization of estrous in the flock to ensure efficiency (Adu *et al*, 2015). Techniques such visual cue achieved by placing female grasscutter close to the male could increase the vaginal Capacity which is a sign of oestrus in most Rodents (Nyameasem *et al*, 2015).

Nutritional constraints

The domestication of cane rat has its own teething constrains, which include the need to provide regular supply of feeds rich and balanced in nutrients. It has been observed that grasscutter prefer grasses such as elephant grass, fresh maize husk, sugar cane, guinea grass with succulent stalk which may not be readily available (Akinola *et al*, 2014). In captivity therefore meeting this nutritional requirement may not be achieved by the farmer hence productivity will be low. Adu *et al*, (2017) stated that the poor reproductive performance of the grasscutter in captives can partially be attributed to the poor understanding of the nutritional physiology of the animal. Food availability can also be link to seasonality of the country; forage during the dry season may not be available or may have depreciated in value. Hence, attempt should be made in developing compounded feeds which will be rich in nutrients and the same time can be found all year round.

Diseases and mortality

Disease is one the key factor limiting livestock production. The profit margin and the viability of the business depend greatly on disease management. A single disease may cause total mortality in some livestock. High disease prevalent is associated with high neonatal mortality in livestock (Akinnola *et al*, 2015). Severity of disease in livestock has also being linked with poor nutritional quality (Opara and Fagbemi, 2009). Poor management practices have been linked to increase in disease, William *et al*, (2011) reported that more grasscutters died when they were housed in iron cages at the beginning of farm operation than when they were housed in block-cement pens. Diseases associated with grasscutter includes pneumonia, intestinal helminth, trypanosomes (although no clinical signs), others includes ectoparasites such as flea (*Xenopsyla* spp) and ticks (*Rhipicephalus simpsoni, Ixodes aulacodi, Ixodes sp* and *Haemaphysalis parmata*), other parasites such *Heterakis* spp and *Hymenolepis* (Akinola *et al*,2015).It is interesting to note that the grass cutter had not been traced to harbor pathogens that can affect humans. Ebola virus disease for example, had been traced to chimpanzees, gorillas and bonobos and may spread to humans when the meat is handled or consumed (Akinola *et al*, 2014).

Conclusion

Cane rat if properly managed and improve open is capable of meeting the protein requirements and reduce unemployment problem in Nigeria. Despite its numerous prospects, its domestication is not devoid of some challenges. In this era (post Ebola) effort is needed to encourage farmer who are interested in farming/ domesticating grasscutter in form of training and awareness to get the needed techniques required to be successful in the business. Grasscutter is not known to transfer any serious disease to man, but the perception that eating bush meat may transmit disease to man may affect its marketability and patronage. In other to reduce this, public enlightenment should be encouraged to tell people about the advantage of having a grasscutter farm.

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Effect of Dietary Level of Palm Kernel Meal and Enzyme on Growth Performance of Broiler Chicken

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Abstract
Studies were conducted to determine the response of broilers fed palm kernel meal (PKM) based diets with or without enzyme (Anazyme Forte®) supplementation. One hundred and forty four 7 day-old Anak (unsexed) broiler chicks were randomly divided into six groups of 24 birds each. The design of the experiments was in a 3 x 2 factorial in a completely randomized design (CRD). The test ingredient, PKM was at three levels (20, 30 and 40%) of the diet while the enzyme was at two levels (0 and 0.5%). Each treatment was replicated three times with 8 birds per replicate. Birds were fed feed and water ad libitum. Results showed that enzyme supplementation significantly ($p<0.05$) increased final body weight (FBW), daily body weight gain (DWG), protein efficiency ratio (PER) and decreased daily feed intake (DFI), feed conversion ratio (FCR) and daily protein intake (DPI). FBW, DWG, PER decreased and DFI, FCR, DPI increased with increase in the levels of PKM. There were no significant ($p>0.5$) mortality among the birds .Also there was no interaction between PKM and enzyme. It was concluded that PKM could be included in the diet of broilers up to 30% without enzyme supplementation and up to 40% with enzyme (Anazyme Forte®) supplementation without adverse effect on performance of broiler.

Introduction
Inadequate feeding and poor management practices are some of the major problems affecting animal production in developing countries like Nigeria. The high cost of production of cereals, which constitute the major source of energy in poultry diets has necessitated the search for alternative ingredients to replace wholly or partially these cereals. Animal nutritionists are challenged every day to assess the nutritive value of feedstuffs available in their communities and to propose the possible combinations of these feedstuffs in complete feeds that meet the nutrient requirements of livestock at a reasonable cost. ,Feed alone accounts for up to 70 - 80% of the total cost of broiler production and adequate nutrition is one of the major inputs necessary for the full expression of the genetic potentials of poultry, and the prevention of stress (Adene, 1989). Poultry production is one of the most economic routes for producing high quality animal protein within the shortest possible time for the rapidly increasing human population across the world, especially in Nigeria. This is because of their short generation interval and the intensive method of production, which allows high stocking density. Poor productivity and high mortality of poultry is largely explained by the inadequacy of feeding the right quantity and quality of feeds when diseases are eliminated. Consequent to these feeding problems, research efforts over the years had attempted to increase the use of cheap agro-industrial by-products like palm kernel meal (PKM), wheat offal (WO), rice bran (RB), brewer's dried grain (BDG), maize milling by-product, and maize offal (MO) (Onwudike, 1988). The use of non-conventional feed ingredients in broiler diets is expected to worsen the effects of anti-nutrients on broiler performance and nutrient excretion into the environment. One of the key technologies that could help address this

challenge is the use of appropriate enzymes. The enzyme technology has progressed a great deal over the past years with respect to efficacy and matching activities with their target substrates. For example, β- glucanases and xylanases for degradation of the β-glucans and arabinoxylans in barley, oats, wheat, rye and triticale have proven efficacy in enhancing the nutritive value of these grains for poultry (broilers in particular). The benefits of using enzymes in monogastric diets include not only enhanced growth performance and feed conversion, but also fewer environmental problems due to reduced output of excreta. Poultry do not have the endogenous enzymes necessary for breaking down of non-starch polysaccharides (NSPs). Enzymes have been approved for use in poultry feed because they are natural products of fermentation and therefore pose no threat to the animal or the consumer (Vukic Vranjes and Wenk, 1993). Their use in poultry feeds has been related to the hydrolysis of fiber or non-starch polysaccharide (NSP) fraction of cereal grains. These NSPs cannot be digested by the endogenous enzymes of poultry and could have anti-nutritive effects. They cause an increase in viscosity of intestinal content and entrap large amounts of digestible nutrients like starch and proteins. The use of commercial feed enzymes in livestock feeding has opened a new horizon for the use of hitherto waste feedstuff. Results of experiments (Atteh, 2000) showed that with the use of a bacterial xylanase enzyme, it was possible to replace 50% of maize with wheat offal without detrimental effect on broiler performance. The present study therefore was to determine the effect of dietary levels of palm kernel meal (PKM) and enzyme (Anazyme®) on the growth performance of broiler chicken.

Materials and Method

This study was conducted at the Poultry Unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia State. The palm kernel meal and other feed ingredients used in the study were procured from Umuahia main market, Abia State .One hundred and forty four Anak breed 7 day-old chicks were randomly divided into 6 groups of 24 birds each. The groups were randomly assigned to 6 diets containing three levels of PKM (20, 30, and 40 %) and two enzyme levels (0 and 0.5 %) . The design of the study was completely randomized design in a 3x2 factorial arrangement consisting 6 treatments with or without enzyme. Each treatment was replicated three times with 8 birds per replicate. Feed and water were supplied *ad libitum* on deep litter system of management for the study period of 7 weeks. Feed intake was recorded daily and birds were weighed weekly. Data on feed conversion ratio, protein efficiency ratio and mortality were recorded. The chemical analysis of the proximate compositions of the experimental diets were determined according to the procedure of A.O.A.C.(1990). Data collected were subjected to analysis of variance (Steel and Torrie, 1980). Means with significant difference were separated using Duncans New Multiple Range Test (Duncan, 1955).

Results and Discussion

The proximate DM percentages of the diets ranged from 90.17 to 90.70 and followed no trend (Table 1). The CP (%), CF(%), EE(%) ash content varied between enzyme levels and increased with increasing levels of PKM. The NFE(%) and gross energy varied between enzyme levels but decreased with increasing levels of PKM. The proximate results for diets supplemented with enzyme were higher than those without enzyme except DM(%) which has slight deviation in diet 3. The effect of level of enzyme supplementation on the performance of broilers is presented in Table 2. The final live weight (FLW), daily weight gain (DWG) protein efficiency ratio (PER) of birds fed dietary PKM based diet with enzyme supplementation were significantly ($P<0.05$) higher than those fed diets without enzyme supplementation. The daily feed intake (DFI), feed conversion ratio (FCR) and daily protein intake (DPI) of birds fed enzyme supplemented PKM diets were relatively lower than those fed diets without enzyme supplementation. Varying levels of dietary PKM had significant ($P<0.05$) effect on the final live weight (FLW), daily weight gain (DWG), daily feed intake (DFI), feed conversion ratio (FCR), daily protein intake (DPI), and protein efficiency ratio (PER) . The FLW, DWG and PER had inverse relationship with inclusion level, thus decreasing with increasing rate of PKM level. On the other hand, average DFI, FCR and DPI were increasing with increasing rate of PKM level. There were no significant ($P>0.05$)

interaction effect between enzyme supplementation and PKM levels on all the parameters studied (Table 3). The FLW of birds fed 20% and 30% enzyme supplemented palm kernel meal diets were significantly ($p<0.05$) similar ; but birds fed 30% enzyme supplemented dietary PKM were similar to those fed 20% PKM diet without enzyme .DWG of birds fed enzyme supplemented diets (20, 30 and 40%) were similar and, in the same manner they were similar to birds fed 20% PKM diet without enzyme. Daily feed intake (DFI), feed conversion ratio (FCR), daily protein intake (DPI) and protein efficiency ratio (PER) of birds fed enzyme supplemented PKM were better than those fed PKM diet without enzyme. Generally, there was reduced ($P>0.05$) performance as the inclusion level increased. These variations in the performance traits indicate that the effect of PKM levels in the diets depended on the enzyme levels. The improved final live weight, DWG, DFI, FCR, DPI and PER in the birds fed enzyme supplemented diets relative to those on diets without enzyme supplementation, was due to enzyme effect as reported by Choct (2006), who stated that when enzymes are added to high fiber monogastric diets, they cause the degradation of β- mannan and 70% NSPs into soluble metabolizable products for monogastric. Feed intake was decreased in the enzyme supplemented diets compared to diets without enzyme. Ezieshi and Olomu (2004) reported higher feed intake in birds fed PKM. In similar study Atteh (2000) and Esuga *et al.* (2008) separately observed improvements in weight gain and FCR in birds fed enzyme supplemented diets. Our results have shown that enzyme supplementation of PKM based diet caused an enhanced performance in the birds. Similar, results have been reported by Iyayi and Tewe (1998) in layers, Iyayi and Adegboyega (2004), in broiler. The observed increase in feed intake by birds that consumed the diets without enzyme supplementation suggests that the birds wanted to meet their nutrient requirements and the observed decrease in feed intake by birds that consumed enzyme supplemented diets could be attributed to the enzyme. The observed decrease agreed with the findings of Ani and Omeje (2007), that enzyme supplementation of poultry diets results in decrease in feed intake. This could be attributed to improved energy availability and utilization for the growth of poultry (Aboosadi *et al*., 1996). The birds therefore, tend to consume less amount of feed when their nutrient requirement has been met. However, the results contradict the findings of Augelovicova and Michalik (1997) that the addition of enzyme to the diets of poultry resulted in increased feed consumption. The incremental levels of inclusion of PKM affected most of the performance indices of broiler significantly ($P<0.5$). A possible explanation for the reduced final live weight, DWG and PER as level of inclusion of PKM increased could include higher total intake of higher fiber diets. Fiber has been considered as a nutrient diluent in broiler diets that does not affect digestion and absorption of nutrients (Edwards, 1995), however, that observation is only reported for moderate levels of fiber (Hetland and Svihus, 2001). Higher fiber concentrations in chick diets can have negative effects on nutrient digestion and absorption (Krogdahl, 1986) and may subsequently affect performance as seen in FLW, DWG and PER responses of the broiler chicks in the current study. Similar observation had earlier been reported (Apata and Ojo 2000). Increasing dietary PKM to 40% level resulted in increased values for DFI, FCR and DPI. This depression in these growth indices could be due to high fiber diet and the need to obtain the necessary nutrients by consuming more feed. A possible explanation to the significant ($P<0.05$) decrease in DWG as PKM level increased for birds fed diets without enzyme supplement could be attributed to decrease in digestibility and utilization of the diets emanating from the high-fibre contents. Ajaja *et al.* (2003) has observed that high fibre content of diets decreased nutrient utilization and result in metabolic dysfunction with the attendant weight reduction in monogastric animals. The birds fed the high fibre diets could have utilized most of the available nutrients for maintenance purpose and channelled less nutrients for growth hence the observed depressed growth. On the other hand supplementation of the diets with enzyme resulted in significant ($P<0.05$) improvement in weight of the birds over the birds fed diets without enzyme supplementation. Iyayi and Tewe (1998) reported similar results in layers. Iyayi and Adeboyiga (2004) in broilers. Such enhanced weight gain could be attributed to improved digestion and utilization of NSPs in dietary fibre due to enzyme inclusion. Birds fed diets without enzyme supplementation had the highest feed intake in chickens is inversely related to dietary energy concentration. Increase in dietary fibre level is known to result in decrease in dietary energy level of the diets (Kung Macdonald *et al.,* 2002). Since birds eat to satisfy their energy requirement (Jurgens, 2007), birds fed high level dietary fibre had to consume more feed than other birds in order to meet their energy requirements.

Conclusion

The results of this study showed that PKM can be used up to 30% in broiler diet without enzyme supplementation and up to 40% with enzyme (Anazyme Fort®) without adverse effect on the growth performance.

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Table 1: Percentage Composition of Experimental diets of Broiler chicken (2-8weeks)

Ingredient	*Diet1*	*Diet 2*	*Diet3*	*Diet 4*	*Diet 5*	*Diet 6*
Maize	57.00	47.00	37.00	57.00	47.00	37.00
PKM	20.00	30.00	40.00	20.00	30.00	40.00
Soybean meal	15.50	15.50	15.50	15.50	15.50	15.50
Fish meal	4.00	4.00	4.00	4.00	4.00	4.00
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50
Salt (NaCl)	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Totals	100	100	100	100	100	100
Calculated Nutrient Composition (%)						
Metabolizable energy Kcal/kg	2995.82	2922.62	2849.42	2995.82	2922.62	2849.42
Crude Protein %	18.82	19.81	20.80	18.82	19.81	20.80
Determined Analysis						
Dry Matter (%)	990.17	90.68	90.44	90.45	0.67	90.70
Crude protein (%)	119.15	19.76	20.17	19.64	19.95	20.20
Crude fiber (%)	66.78	7.70	8.25	6.06	7.03	7.11
Ether Extract (%)	33.12	3.81	4.01	3.20	3.96	4.20
Crude Ash (%)	55.06	6.31	7.89	5.42	6.50	8.05
Nitrogen free-extract (%)	556.06	53.10	50.12	56.13	53.23	51.14
Gross Energy (Mcal/g)	2.64	2.21	1.79	2.74	2.32	2.21

Diets 1, 2 and 3 = without enzyme supplementation
Diets 4, 5 and 6 = with enzyme supplementation.

Table 2: Main effect of dietary levels of PKM and enzyme on performance of broiler chicken (2-8 wks).

	Enzyme Level (%)			**Palm Kernel Meal Level (%)**			
Parameter	**0.00**	**0.50**	**SEM**	**20**	**30**	**40**	**SEM**
Initial live weight (g/bird)	111.24	110.61	0.56	110.24	112.04	110.59	0.69
Final live weight (g/bird)	2392.39^b	2528.39^a	19.08	2542.23^a	2463.48^b	2375.46^c	23.36
Daily weight gain (g/bird)	46.55^b	53.95^a	0.60	49.63^a	47.99^b	46.22^c	0.73
Daily feed intake (g/bird)	113.69^a	102.71^b	0.72	101.64^c	108.15^b	114.81^a	0.88
Feed conversion ratio	2.44^a	2.08^b	0.05	2.05^c	2.25^b	2.48^a	0.55
Daily protein intake (g/bird)	22.53^a	22.45^b	0.15	19.12^c	21.42^b	23.88^a	0.19
Protein efficiency ratio	2.07^b	2.44^a	0.03	2.60^a	2.24^b	1.93^b	0.04
Mortality (%)	4.17	0.00	0.01	0.00	2.09	4.17	0.03

a,b,c means within rows with different superscripts are significantly different ($P<0.05$) SEM= standard error of mean.

Table 3: Effect of interaction between Enzyme supplementation and palm kernel meal level on the performance of broilers (2-8 weeks)

		Palm Kernel Meal Level (%)			
Parameter	**Enzyme level**	**20**	**30**	**40**	**Mean**
Initial live weight (g/bird)	0.00	110.47	112.40	111.00	111.29
	0.50	110.00	111.67	110.17	110.61
	Mean	110.24	112.04	110.59	
	SEM	0.97			
Final live weight (g/bird)	0.00	2465.56^{bc}	2390.17^{cd}	2321.42^{d}	2392.38
	0.50	2618.89^{a}	2536.78^{ab}	2429.50^{c}	2528.39
	Mean	2542.25	2463.48	2375.46	
	SEM	33.05			
Daily weight gain (g/bird/ day)	0.00	48.06^{abc}	46.49^{bc}	45.11^{c}	50.74
	0.50	51.20^{a}	49.49^{ab}	47.33^{abc}	53.95
	Mean	73.66	47.99	46.22	
	SEM	1.03			
Daily feed intake (g/bird/day)	0.00	107.87^{c}	112.95^{b}	120.25^{a}	130.24
	0.50	95.41^{de}	103.35^{d}	109.37^{bc}	117.87
	Mean	101.64	108.15	114.81	
	SEM	1.45			
Feed conversion ratio	0.00	2.24^{bc}	2.43^{ab}	2.67^{a}	2.58
	0.50	1.86^{d}	2.09^{cd}	2.31^{b}	2.20
	Mean	2.05	2.26	2.31	
	SEM	0.08			
Daily protein intake (g/bird/day)	0.00	20.30^{c}	22.37^{b}	25.01^{a}	24.80
	0.50	17.96^{cd}	20.41^{c}	22.75^{b}	22.45
	Mean	21.05	21.39	23.88	
	SEM	19.13			
Protein efficiency ratio	0.00	20.30^{b}	2.07^{c}	1.79cd	2.07
	0.50	2.84^{a}	2.41^{b}	2.06^{c}	2.44
	Mean	2.60	2.24	1.93	
	SEM	0.04			
Mortality (%)	0.00	0.00	4.17	8.33	4.17
	0.50	0.00	0.00	0.00	0.00
	Mean	0.00	2.09	4.17	
	SEM	0.06			

a, b, c means within rows with different superscripts are significantly different ($P<0.05$) SEM= standard error of mean. LW= live weight, DWG= daily weight gain, DFI = daily fed intake, FCR = feed conversion ratio, DPI = daily protein intake, PER = Protein efficiency ratio

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Proximate Composition and Amino Acid Profile in Raw and Processed *Cassia obtusifolia* Seed Meal

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Abstract
The study was conducted to determine the proximate composition and amino acid profile of Cassia obtusifolia seed meal as an alternative plant protein source in poultry diets. Triplicate samples from the raw, boiled, fried and autoclaved were milled into powder. Dry matter, ether extract, crude fiber and ash were determined while the carbohydrates contents were calculated. Proximate composition results showed high dry matter range value of 95.24 to 96.56 %. Crude protein values of 16.54, 17.03, 17.27 and 17.78 % obtained for boiled, fried, raw, and autoclaved cassia obtusifolia, while the crude fiber values of 18.40, 21.42, 21.52, and 22.92 % for autoclaved, fried, raw and boiled samples respectively. The Nitrogen free extract (NFE) values recorded in this study are 45.93, 50.88, 53.33 and 54.83 % for boiled, fried, autoclaved and raw Cassia obtusifolia seed respectively. The ash contents were 3.14, 4.16, 3.39 and 3.39 for autoclaved, boiled, fried and raw Cassia obtusifolia seed meal. The amino acid profile reveals that the seed subjected to autoclaving, boiling, roasting had amino acids contents lower than raw except for alanine, valine which recorded higher values when the seeds were boiled. It was generally observed that amino acid contents were slightly reduced as a result of processing methods employed. The amino acid (g/100g protein) composition of the raw and differently processed Cassia obtusifolia shows that Leucine was the most concentrated essential amino acid (6.27 g/100 g to 7.50 g/100 g crude protein, while Glutamic acid was the most concentrated amino acid (11.01 g/100 g protein) in the raw Cassia obtusifolia. The least concentrated amino acid was Methionine (0.81g/100 g protein to 1.01g/100 g protein recorded in this study. In conclusion, Senna obtusifolia seed meal contains appreciable quantities of nutrients and amino acids but is limiting in Phenylalanine, methionine, cysteine, histidine and lysine when compared to the established standard by FAO therefore, its use as plant protein with other feed ingredients rich in the limiting amino acids to feed poultry is recommended.

Introduction
Global food security is high on the development agenda; some estimates anticipate that a 50 to 70% increase in food productivity will be needed by 2050 to feed additional two billon people (Ingram *et al*., 2010). This is especially crucial for developing countries, where the problem of feeding poor people have been highlighted. With the anticipated population growth, urbanization, and income growth, especially in Nigeria, huge increase in demand for animal source food is envisaged; this demand will place enormous pressure on the global food system. To attain this goal, cheap sources of feed ingredients may be the best option as feed constitutes 70-80% cost of production in livestock industry (Ingweye *et al*., 2010). In the recent years, there has been a gradual increase of interest in the use of non-conventional plant protein sources that are considered safe and without any adverse side effects for use in poultry diets. Thus a search for new feed ingredients with better and cheaper substitutes for conventional feed ingredients is a natural choice. Evaluation of feed ingredients for quality is essential for providing information

on their composition as well as their suitability for poultry. Therefore before adoption of a given feed resource in livestock feeding, preliminary tests for its composition, nutritional value and health implications of its consumption are essential *Shivprasad et. al. (2012*). The exhaustive literature survey reveals that there is scanty information on proximate composition and amino acid profile of *Cassia obtusifolia* seed meal hence this work had been carried out.

Materials and Methods

Study Area

Proximate compositions were determined at Animal Care Laboratory, Ogere, Iperu, Remo, Ogun State Nigeria while the amino acid profile were determined at the biological Laboratory, University of Jos, Plateau State.

Source of *Cassia obtusifolia* seeds

Mature seed of *cassia obtusifolia* were harvested in the month of October around Maiduguri Metropolis Borno State, Nigeria. The pods containing the seeds were properly dried and threshed to obtain the seeds that were used for proximate analysis and feeding trials.

Processing of *Cassia obtusifolia* seed

The seed samples were thoroughly cleaned and sorted to remove extraneous materials. They were divided into five (5) batches each of 100 g. The seeds were processed as follows:

(i) **Raw seed:** cleaned seeds were sun dried for 72 hours and milled into powder using laboratory blender to pass through a 1mm sieve screen and tagged as RCOSM.
(ii) **Boiling:** seed samples were boiled in distilled water in the ratio of 1:10 w/v at a temperature of 100^0 C for 30 minutes, sun dried for 72 hours and milled using a attrition milling machine to obtain a particle size of 1mm mesh size, sample was tagged as BCOSM.
(iii) **Roasting:** seed samples were roasted using Aluminum pot for 30 minutes. The seeds were removed and left to cool and later milled using the attrition machine to obtain 1mm particle size. Sample was tagged as FCOSM
(iv) **Autoclave:** the seed samples were autoclaved at a pressure of 15 lb (125˚C) for 30 minutes after which the seeds were dried and milled to 1 mm mesh size and tagged as ACOSM.

Proximate Composition Determination

The seed meal was analyzed in triplicate for crude protein, crude fibre, ether extract and ash while nitrogen free extract was calculated. This was done according the methods of AOAC (1990).

Determination of Amino Acid Profile

Amino Acid Profile Determination.

The amino acid profile of *Cassia obtusifolia* seed meal was determined using methods described by Spackman *et al*. (1958). The sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Technicon Sequential Multi-Sample Amino Acid Analyzer (TSM) using ion-exchange chromatography (Technicon Instruments Corporation, Dublin, Ireland). The analysis was carried out at the analytical laboratory of the department of biological Science University of Jos. Amino acid values were calculated from chromatograph as described by Spackman *et al*. (1958).

Results and Discussion

Proximate composition

The proximate composition of raw and processed *cassia obtusifolia* seed are shown in Table 1. The crude protein values of 16.54, 17.03, and 17. 27 and 17.78 % obtained for boiled, fried, raw and autoclaved *cassia obtusifolia* seed, this is similar to 18. 46 and 19.4 % reported by (Fetus *et al*., 2010), (Ismaila *et al*., 2011) but lower than 21.4, 29.54, 20.3, 21.89 and 24 % obtained and reported by Ingweye *et al*, 2010; Agbo, 2004; Augustine *et al*. 2014; Vadivel and Janardhanan, 2005; Adjouji, 2005. The variation may be due to differences in geographical location, soil factors, and effect of climate changes. The least value of 16.54 % obtained in *cassia obtusifolia* seed subjected to boiling method of detoxification may be attributed to leaching of nutrient due to boiling. The decrease in crude protein value as a result of boiling is in line with observation of earlier report by Akinmutimi and Onwukwe (2002). This however, did not agree with findings of Audu and Aremu (2011) who reported an increase in crude protein value of red kidney bean subjected to boiling. The dry matter values obtained ranged from 95.24 to 96.56 %. These values were higher than values of 92.49 to 92.50, 93.2 % obtained for *Cassia obtusifolia* seed (Ingweye *et al*., 2010, Vadivel and janardharan, (2005). Similarly, these values were higher when compared to the values reported for sword bean (63.6 %), lima bean (65.8 %), African yam bean (70.33 %), pigeon pea (68.8 %), Jack bean (69.4 %), Bambara Groundnut (67.5 %) and Soya bean (67.3 %) (Festus *et al*., 2010), but similar to 96 % reported by Ismaila (2011). High dry matter content is valuable asset in storage and preservation. The crude fiber values of 18.40, 21.42, 21.52, and 22.92 % obtained in this study was not in conformity with earlier reports of Ingweye *et al*, (2010), Ismaila (2011), Festus *et al*, (2010) and Augustine *et al*, (2014) who reported crude fiber values of 10.18, 5.2, 6.80 and 12.45 % for raw *Cassia obtusifolia* seed. Though crude fiber does not contribute to the nutritive value of food, the presence of fiber in diet is necessary for digestion and for efficient elimination of waste. The crude fiber value fell within the world health organization (WHO) recommendation of 22 to 23 g/1000 kcal of diet. The high fiber level could be due to the tough seed coat. Nitrogen free extract (NFE) values recorded in this study are 45.93, 50.88, 53.33 and 54.83 % for boiled, fried, autoclaved and raw *Cassia obtusifolia* seed. These values are lower compared to 68.54 % figure reported for *Cassia obtusifolia* seed (Ismaila *et al.*, 2011) and comparable to 46.77 % reported by Ingweye *et al.* (2011). It also compares well with the values of 44.6 to 47.4 % of different varieties of sesbania seed reported by Huisian and Tolman (2001) and 43.3 to 60.3 % reported for Jack bean (Ajah and Madubuike, 1997). The values of nitrogen free extract and ether extract are indicative that *Cassia obtusifolia* can also be used as energy feed stuff for livestock especially monogastric. The ether extract value recorded in this study was lower than values of 7.4 % (Vadivel and Janardhanan, 2005), 7.0 % (Abdalbasit, 2008) obtained in similar studies for *Cassia obtusifolia* seed, but similar to values of 3.6 , 3.3 and 3.1 %, for Sword bean, Jackbean and African Yam bean (Festus *et al*. 2010). The Ash content of 3.14, 4.16, 3.39, and 3.77 % for autoclaved, boiled, fried and raw *Cassia obtusifolia* seed recorded in this study was comparable to value of 3.70 % (Ingweye *et al*., 2010). The Ash content is within 2.7 % to 5.1 % range found in literature for legumes that served as food sources of minerals.

Table 1: Proximate composition of raw and differently processed *Cassia obtusifolia* seed meal

	ACOSM	BCOSM	FCOSM	RCOSM	SEM	P-VALUE
CP (%)	17.78^{b}	16.54^{a}	17.03^{a}	17.27^{a}	0.68	0.0001
DM (%)	96.19	95.24	96.05	95.56	0.41	0.3791
ASH (%)	3.14	4.16	3.39	3.77	1.02	0.3700
EE (%)	4.35	5.69	3.32	3.87	1.07	0.4849
CF (%)	18.40	22.92	21.42	21.52	5.15	0.9356
NFE (%)	53.53	45.93	50.88	54.83	4.70	0.5771

CP=Crude protein, DM=Dry matter, EE= Ether extract, CF=Crude Fibre, NFE=Nitrogen free extract, ACOSM=Autoclaved *Cassia obtusifolia* seed meal, BCOSM=Boiled *Cassia obtusifolia* seed meal, FCOSM= Fried *Cassia obtusifolia* Seed meal, RCOSM=*Raw Cassia obtusifolia* seed meal, SEM=Standard error of mean, abcd =means within the same row having different superscript differ significantly

Amino acid profile

The data on amino acid profile are presented in Table 2. The Phenylalanine content recorded in this study ranged between 3.70 g/100 g to 4.56 g/100g protein. These values are comparable to values 4.6 g/100g protein for raw kidney bean seed (Audu and Aremu, 2005) and 4.50 g/100 g protein reported by (Ingweye *et. al*., 2010) for raw *Cassia obtusifolia* seed. On the contrary it was higher than 2.8 g/16 g FAO reference value and lower than 5.6 g/16 g reported by Mubarak (2005) for Mung bean seed. Leucine was the most concentrated essential amino acid (6.27 g/100 g to 7.50 g/100 g crude protein, while Glutamic acid was the most concentrated amino acid (11.01 g/100 g protein) in the raw *Cassia obtusifolia*. This finding corroborates with earlier report of Audu and Aremu (2005) who reported Leucine and Glutamic acid values of 7.2 g/100 g to 8.2 g/100 g protein and 10.2 g/100 g protein in raw red kidney beans. The value of leucine obtained in this study agrees and compares favorably with values obtained by some workers on studies of some Nigerian legumes Lima bean (7.5 g/100 g protein, African Yam bean (7.45 g/100 g protein reported by Oshodi *et al*. (1998). to the raw seed. This slight reduction could be due the transamination and deamination reaction in processed *Cassia obtusifolia* seed. This finding agrees with earlier report of Uko and Kamadu (2008) who reported reduction in values of leucine and lysine in Neem kernel subjected to heat treatment. The reduction in amino acid values of *Cassia obtusifolia* seed subjected to different processing methods will require supplementation with essential amino acids such as Methionine, Cysteine and Lysine. The least concentrated amino acid was Methionine (0.81g/100 g protein to 1.01g/100 g protein recorded in this study. Boiling method in this study enhanced the values of Alanine and Valine from 3.94 g/100 g to 4.07 g/100 g protein and 3.71 g/100 g to 4.0 g/100 g protein respectively. All other amino acids investigated in this study were slightly reduced as a result of processing compared.

Table 2: Concentration of amino Acid (g/100g protein) in raw and differently processed *Cassia obtusifolia* seeds

Amino acid	ACOSM	BCOSM	FCOSM	RCOSM	SEM	P-Value
Alanine	3.56^c	4.07^a	3.85^b	3.94^b	0.27	0.0001
Arginine	3.99^d	4.37^a	4.67^b	5.01^a	9.72	0.0001
Aspartic acid	7.90^d	8.65^c	8.76^b	9.01^a	0.01	0.0001
Cysteine	0.08^d	0.95^c	1.05^b	1.14^a	9.43	0.0001
Glutamin	9.39^d	10.24^b	9.74^c	11.01^a	0.02	0.0001
Histidine	2.12^d	2.36^b	2.27^b	2.54^a	0.02	0.0001
Isoleucine	2.75^d	3.11^b	2.96^c	3.51^a	0.02	0.0001
Leucine	6.74^c	6.27^d	7.10^b	7.50^a	0.02	0.0001
Lysine	3.00^c	3.58^b	3.60^b	3.99^a	0.03	0.0001
Methionine	0.81^d	0.85^c	0.93^b	1.01^a	9.72	0.0001
Phenylalanine	3.79^c	3.70^d	4.12^b	4.56^a	0.01	0.0001
Proline	2.96^d	3.18^c	3.49^b	4.00^a	8.81	0.0001
Serine	2.65^c	2.92^b	2.95^b	3.37^a	0.002	0.0001
Threonine	2.76^d	2.89^c	3.37^b	3.97^a	9.42	0.0001
Tyrosine	3.04^d	2.88^c	3.37^b	3.37^d	7.45	0.0001
Valine	3.49^b	4.01^c	3.61^a	3.71^a	0.03	0.0001
Total(AA)	59.03	59.96	65.84	71.64S		

ACOSM=Autoclaved Cassia Seed Meal, BCOSM= Boiled Cassia seed meal, FCOSM=Fried Cassia Seed meal, RCOSM= Raw Cassia seed meal
abcde = Means within the same row having different superscript differed significantly ($P< 0.05$), SEM=Standard error of meal

Conclusion

It was generally observed that amino acid values of the test ingredients were reduced slightly as a result of processing. The reduction in amino acid values of *Cassia obtusifolia* seed subjected to different processing methods will require supplementation with essential amino acids such as Metionine, Cystine and Lysine. Nitrogen free extract values of the test ingredients in this study, indicates its potential as energy source.

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Growth Performance and Gut Morphometry of Rabbit Bucks Fed *Moringa oleifera* Leaf Extracts in Water

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Abstract
A 65-day study was conducted on sixteen (16) rabbit bucks, aged 10–11 weeks to investigate the effect of four levels of Moringa oleifera crude leaf extract (MOCLE) on their growth performance and gut morphometry. Four (4) rabbits each were randomly assigned to 4 treatments in a completely randomized design and each rabbit served as a replicate. The treatment groups each received a basal diet and 4 levels of MOCLE per litre of drinking water designated as follows: 0 ml (T1), 250 ml (T2), 500 ml (T3) and 750 ml (T4). Feed intake (FI), water intake (WI), total weight gain (TWG), final weight (FW), and feed conversion ratio (FCR) were determined. At day 65 of the trial, the rabbits were sacrificed, eviscerated and the gastrointestinal tract (GIT) morphometry were determined to include the lengths (cm) and weights (g) of the oesophagus, stomach, small intestine, caecum and colon. FW and TWG differed significantly (P < 0.05) and T4 (750 ml MOCLE) produced the highest FW (2206.25 g) and TWG (812.50 g) values. FI and FCR were similar (P > 0.05) across the treatment and ranged from 51.88 – 60.40 g/d and 4.82 –5.57 respectively. WI decreased as the levels of MOCLE increased with T1 (595.25 ml) recording the highest value followed by T2 (392.25 ml), T3 (364.13 ml) and T4 (282.25 ml) respectively. All the GIT morphometry of the rabbits studied did not vary significantly (P > 0.05). In conclusion, the 250 – 750 ml levels of MOCLE supported better weight increments in rabbits and did not cause marked changes in gut measurements. Therefore, the inclusion of the 750 ml level of MOCLE in the drinking water of rabbit bucks is well tolerated and recommended for increased growth response.

Introduction
The advent of incorporating various plant extracts in animal feeding trials has over the years witnessed increased exploitation due to numerous health benefits which are well documented. *Moringa oleifera* Lam. is one of such plants that have received attention due to its nutritional and medicinal properties that abound in literature. The leaves of *Moringa oleifera* is rich in proteins, vitamins, minerals (Pandey *et al.*, 2012) and potent antioxidants (Yang *et al.*, 2006); the fresh leaves contains 76.53 % moisture, 27.51 % crude protein, 19.25 % crude fibre, 2.23 % ether extract, 7.13 % ash, 43.88 % carbohydrates and 1296 KJ g^{-1} ME (Oduro *et al.*, 2008). The leaves also contain essential amino acids at levels that are similar to soya beans (Ferreira *et al.*, 2008). The positive effect of *Moringa* leaves in the form of leaf meals has been previously demonstrated on the growth performance of rabbits (Kpodekon *et al.*, 2009; Nuhu, 2010; Dougnon *et al.*, 2012). *M. oleifera* leaf extract has found extensive use in pharmacological studies mainly carried out on rats, mice and rabbits as animal models. The recognized methods of obtaining these extracts (soxhlet, decoctions, alchoholic etc) often require standardized procedures which limit their ease of adoption. In spite of the abundant literature on the use of *M. oleifera* leaf extracts in animal studies, there is still not much information on its utilization on growth performance and gastrointestinal tract studies of rabbits, particularly, in the use of its crude leaf juice. Therefore,

the aim of the study was to determine the growth performance and gut morphometry of rabbit bucks fed various levels of *M. oleifera* crude leaf extract (MOCLE) in water.

Materials and Methods

The study was conducted at the rabbitry unit of the Livestock Teaching and Research Farm, Federal University of Agriculture Makurdi, Nigeria. Makurdi is located on latitude 7°45´ N and longitude 8°31´ E within the Southern guinea savannah ecological zone. It has two distinct seasons, the wet and dry seasons with annual rainfall range of 508–1016 mm. Day time temperatures may drop as low as 21.6°C in December/January and rise as high as 42.6°C in February/March. Fresh green leaves of *Moringa oleifera* trees were harvested from Wuse village, Awe local government, Nasarawa state, Nigeria based on abundance. The debris-free leaves were obtained and mashed locally without water added to form a paste. The crude leaf juice was extracted with a muslin (cheese) cloth, refrigerated and used to prepare the final mixtures. A total of 16 rabbit bucks of mixed crosses, aged 10 – 11 weeks, weighing between 1318.75 g and1437.50 g were used in a 65-d feeding trial. Four rabbits each were randomly allotted to four treatments with each rabbit serving as a replicate. The rabbits were housed singly in wooden and wire mesh hutches, dewormed and adjusted for a period of 2 weeks. The rabbits were fed a basal diet and four varying levels of *M. oleifera* crude leaf extract (MOCLE) at 0 ml, 250 ml, 500 ml and 750 ml per litre of drinking water, designated as T1 (control), T2, T3, and T4 respectively. The growth performance indices measured were feed intake (g/d), water intake (ml/d), weight gain (g/d), total gain (g), final weight (g), and feed conversion ratio. At day 65 of the study, the rabbits were starved of feed for about 12 hours but served clean water *ad libitum*, weighed and then sacrificed. The gastrointestinal tract (GIT) were excised, emptied, rinsed, cut into five anatomical parts (oesophagus, stomach, small intestine, caecum and colon) and weighed. The relative length and weight of the gastrointestinal tract cuts were expressed in percents of entire gastrointestinal tract length and live weight respectively. Data were subjected to one-way analysis of variance (ANOVA) using IBM SPSS® (2011) version 20. Significant means ($P < 0.05$) was separated using Duncan of the statistical software.

Results and Discussion

The calculated chemical composition of the basal diet is shown in table 1. The growth performance of rabbit bucks fed MOCLE is presented in table 2. The result did not reveal any significant ($P>0.05$) differences across treatments for feed intake (FI) and feed conversion ratio (FCR) but final weight (FW) and total weight gain (TWG) showed significant differences ($P<0.05$). FW and TWG increased in accordance with the extract levels as T4 (750 ml) produced the highest values. FW in this study was similar to that of Adeniji and Lawal (2012) who reported significant values (1981.1 g – 2216.2 g) when *M. oleifera* leaf meal (MOLM) replaced groundnut cake (GNC) in grower rabbit diets. In contrast, Nuhu (2010) did not observe any significant effect in the FW of rabbits which were lower (1625.31 g – 1902.51 g) when MOLM replaced soya bean meal (SBM). The variations in the FW noted by this author and that of this study could be as result of better availability of proteins from the leaf extracts. The TWG values from this study were at variance with the non-significantly higher values (983.64 g – 1260.84 g) reported by Nuhu (2010). The growth stage of the rabbits used in this study as compared to the other author (6 – 7 weeks) may have accounted for the lower TWG values. FI values was comparable to the not significantly different range (60.10 g – 63.40 g) reported by Nuhu (2010) but was lower than the statistically similar values of 64.53 g to 73.59 g reported by Onu (2012) who fed aqueous leaf extracts of *Telfairia occidentalis* to starter broilers. However, Adeniji and Lawal (2012) reported significantly higher values (64.4 g – 78.5 g) in FI of rabbits. The observed variations between the FI values of this study and those of other works may be due to differences in the growth stages of the rabbits. FCR values in this study agreed with the range of 5.13 to 4.22 reported by Nuhu (2010). Nworgu (2007) and Machebe *et al*. (2010) also reported better FCR in broiler birds fed leaf extracts of *T. occidentalis* and *Gongronema latifolia* respectively. However, Adeniji and Lawal (2012) and Onu (2012) found significant differences in FCR of rabbits and starter broilers respectively. Therefore the better FCR values observed in this present study with the corresponding higher FW among the MOCLE-fed groups suggests that body tissue accretion was not grossly impaired. The weekly water intake (WI) of rabbit bucks fed MOCLE (fig. 1) shows that T1 (0 ml) was most consumed followed by T2 (250 ml), T3 (500 ml) and T4 (750 ml) respectively. The observed pattern in WI suggests that T2 to T4 interfered with the palatability of the water-extract mixtures even though FW and TWG were markedly enhanced. Table 4 presents the result of the gut morphometry of rabbit bucks fed MOCLE. There was no significant differences (P>0.05) in the length and weight of the various gut segments across the treatments. The range of values of the relative length and weight of the small intestine were highest (59.84 – 61.00 % and 1.18 – 1.56 % respectively) while the stomach length (2.00 – 2.23 %) and oesophagus weight (0.07 – 0.08 %) had the least range of values. The stomach, small intestine and caecum weights from this study were lower than the values of 2.5 ± 0.34%, 2.1 ± 0.15 % and 4.7 ± 0.20% respectively reported by Yu and Chiou (1997) for California rabbit bucks fed a commercial diet. The observed differences between the weights of gut segments recorded by these authors and this study could be due to the effect of breed and plane of nutrition. In addition, Yu and Chiou (1979) reported an age-related decrease in relative gut segment weights of rabbits. These authors observed linear increases from early life to the maturity stage at 8 weeks of age, and thereafter declined in contrast to rapid body weight gain. Therefore the result indicates that MOCLE did not cause marked changes in the gastrointestinal tract of the rabbits.

Conclusion

It can be concluded that rabbits fed the supplementary levels of MOCLE at 250 – 750 ml per litre of drinking water recorded remarkable differences in final weight and total weight gain with the 750 ml level producing the best response. The water intake of the rabbits showed decreasing trend as the levels of MOCLE increased from 0 – 750 ml, though, this was of no serious consequence. The gastrointestinal tract morphometry of the rabbits were not prominently changed by the varying levels of MOCLE. It is therefore recommended that the supplementary feeding of rabbits with MOCLE up to 750 ml in drinking water is well tolerated without adverse effect on growth performance and gut morphometery.

Table 1: Chemical composition of basal diet (calculated)

	Nutrient					Digestible energy (kcal/kg)
	Crude protein	Crude fibre	Crude fat	Ash	Nitrogen free extract	
% Composition	16.00	10.04	7.85	5.95	60.17	2822.5

Ingredients: maize 44.1 %, full fat soya bean 23.9 %, rice offal 20.0 %, palm kernel cake 9.5 %, bone ash 2.0 %, table salt 0.3 %, *vitamin premix 0.2 %. *BIOMIX ® GROWER at 0.2 % supplied the following: vitamin A (retinol) 640000 IU; vitamin B_1(thiamine) 160 mg; vitamin B_2 (riboflavin) 200 mg; vitamin B_3 (niacin) 1200 mg; vitamin B5 (pantothenic acid) 440 mg; vitamin B6 (pyridoxine) 160 mg; vitamin B8 (biotin) 20 mg; vitamin B9 (folic acid) 40 mg; vitamin B12 (cobalamin) 0.8 mg; D_3 120000 IU; vitamin E (tocopherol) 560 mg; vitamin K_3 120 mg; Choline Chloride 14000 mg; Cobalt 16 mg; Copper 240 mg; Iodine 80 mg; Iron 1680 mg; Manganese 3200 mg; Selenium 160 mg; Zinc 2480 mg; and antioxidant 100 mg

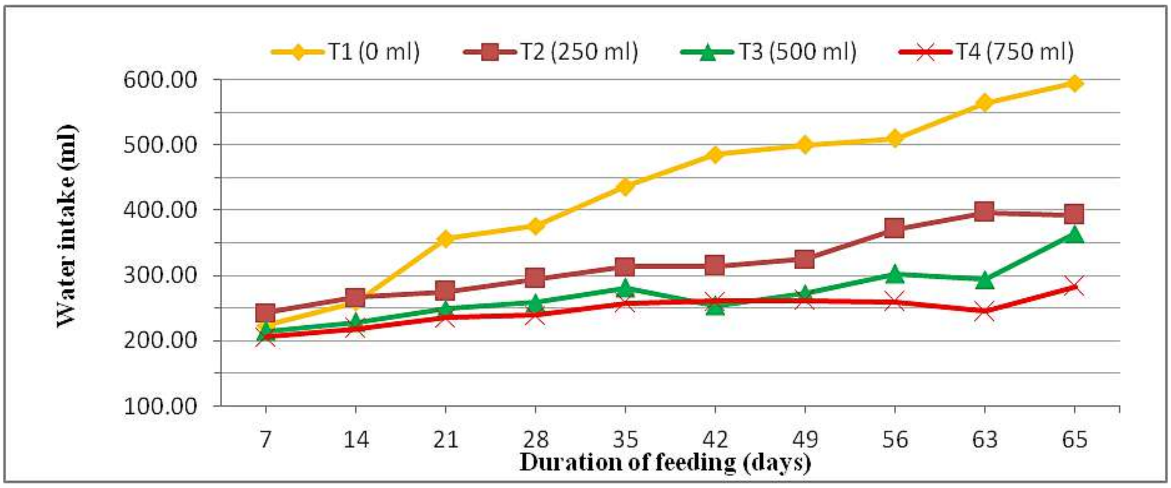

Figure 1: Weekly water intake of rabbit bucks fed *Moringa oleifera* crude leaf extracts

Table 2: Growth performance of rabbit bucks fed *Moringa oleifera* crude leaf extract

Performance indices	Levels of extract in water				± SE	P-value
	T_1 0 ml/L	T_2 250ml/L	T_3 500ml/L	T_4 750ml/L		
Initial weight (g)	1381.25	1318.75	1437.50	1393.75	25.89	–
Final weight (g)	1987.50	2006.25	2156.25^{a}	2206.25	32.03	0.014*
Total weight gain (g)	606.25	687.50	718.75^{b}	812.50	20.98	0.000*
Weight gain (g/d)	9.33^{c}	10.58^{b}	11.06^{b}	12.50^{a}		
Feed intake (g/d)	51.88	57.65	60.40	60.14	1.78	0.318^{ns}
Feed conversion ratio	5.57	5.45	5.48	4.82	1.78	0.318^{ns}

^{a,b} means in the same row with different superscripts differ significantly (P < 0.05)
* significant at 5% ^{ns} not significant (P > 0.05) SE standard error

Table 3: Gut morphometry of rabbit bucks fed *Moringa oleifera* crude leaf extract

Gastrointestinal tract indices	Levels of extract in water				± SE	P-value
	T_1 0 ml/L	T_2 250ml/L	T_3 500ml/L	T_4 750ml/L		
† Lengths (%):						
Oesophagus	2.41	2.46	2.62	2.49	0.31	0.831^{ns}
Stomach	2.23	2.04	2.00	2.01	0.29	0.678^{ns}
Small intestine	59.84	60.67	59.86	61.00	0.59	0.892^{ns}
Caecum	10.72	9.76	10.82	9.74	0.24	0.203^{ns}
Colon	24.81	25.07	24.70	24.76	0.44	0.994^{ns}
†† Weights (%):						
Gastrointestinal tract	4.60	4.41	4.72	4.08	0.14	0.441^{ns}
Oesophagus	0.08	0.08	0.07	0.08	0.36	0.311^{ns}
Stomach	0.74	0.68	0.80	0.75	0.66	0.349^{ns}
Small intestine	1.50	1.56	1.51	1.18	1.46	0.434^{ns}
Caecum	1.07	0.93	1.28	0.94	1.02	0.158^{ns}
Colon	1.22	1.16	1.08	1.13	0.78	0.063^{ns}

^{ns} not significant (P > 0.05) SE standard error
† expressed as percent of gastrointestinal tract †† expressed as percent of live weight

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Comparative Economic Analysis of Feeding Sprouted Sorghum Feed to Broiler Chickens among Poultry Farmers in Bindawa Local Government Area in Katsina State, Nigeria

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Abstract
The study is a Supervised Experience Project (SEP) on the Feeding of Sprouted Sorghum Feed to Broiler Chickens among Poultry Farmers in 'Yar Magaji Community of Bindawa Local Government Area in Katsina State. Random sampling method was used to select thirty (30) small scale poultry farmers who were divided in to three groups in 'Yar-Magaji community of Bindawa LGA. A total of 60-day old chicks were used for this study. The birds were fed with starter mash for the first four weeks. After the four weeks the birds were divided into 3 groups with 20 birds per group of poultry farmers. Each group served as a treatment. Group A were fed with solely commercial feed, each member of group B was fed with 20g of sprouted sorghum in addition to commercial feed and each member of group C was fed with 30g of sprouted sorghum daily also in addition to commercial feed for four (4) weeks. Primary data on the farmers were collected using questionnaire. The results showed that 70 percent of the poultry farmers were male and 30 percent were female, 60% were within age range of 31-40 years, 70% were married. It was also observed that before the introduction none of the participants used sprouted sorghum to feed their poultry birds and all the participants used family labour for their poultry production process. It was also observed that 80% of the participants were not aware of the method of sprouting sorghum for poultry feeds. Average weight gain of 2.40kg, 2.18kg and 2.15kg was obtained for group A, B and C of the birds respectively. A sum total of ₦99938 was spent and a total revenue of ₦158,000 was obtained for the whole work while a net income of ₦58061.98 was obtained. The problems associated with sprouting sorghum feeding were identified by farmers in the study area which were lack of technical knowledge on how to sprout sorghum and lack of capital as well. The expenses reduced from the group fed with sprouted sorghum. It was hence concluded that the use of sprouted sorghum is more economical and convenient since the sorghum used were readily available in the market and within the locality. It was recommended that more poultry farmers should be trained and technically assisted on how to sprout sorghum feed; employ an experienced farm attendant for quality labour services; poultry farmers should be encouraged to form cooperatives in order to source for assistance from government and individuals.

Keywords: Sprouted sorghum, broiler chicks, poultry farmers and comparative economic analysis

Introduction
Poultry refers to all birds domesticated and managed by man for food and profit; these include chicken, duck, turkey, guineas, fowls, quails, geese, pigeon, pheasants, peacocks and ostriches. (Oluyemi and Robert, 2002). Broiler birds, one of the commonest forms of poultry production in Nigeria are one of the major sources of animal protein for human consumption in Nigeria. They

contribute about 10% of the national meat production. A major problem of poultry industry in developing countries today is the high cost of feed ingredients. This problem has reduced the rate of conversion of the poultry industry and has added to the low level of animal protein in the nutrition of the citizens (Adebayo *et al.,* 2008). Edache *et al.* (2005) reported that feed supply has remained a major constraint in animal production due to ever increase cost of conventional feed ingredients. To reduce the cost incurred in broiler production from feed, researchers in northern Nigeria revealed that using sprouted cereal especially sorghum as a partial alternative to commercial feed will serve this purpose. Cereals are the most important staple food for many people in the developed and developing Countries. Processing methods such as Soaking, Sprouting and Fermentation has been reported to improve the nutritional and functional properties of cereals (Jirapa *et al.,* 2001). Sprouting singly significantly increases protein, moisture content and decreases fiber, dry matter, fat and ash level. The ability of the farmer to be able to formulate his livestock feeds, enables him to reduce the cost of production and also his ability to source for his ingredients enables him/her to source for quality ingredients at cheaper price because the lower the cost of ingredients the more his profit margin. Based on this observation, there is need for individual farmers to have the techniques of feeding of sprouted sorghum to broiler chicken at minimum cost, since there is no immediate assistance from the government for the farmers. Feeding poultry with sprouted sorghum can serve as a way out of this problem. Only few poultry farmers are able to afford the high cost of feeds produce by commercial feed producers. If an appropriate solution cannot be provided, then protein deficiency will continue to be a big problem in this country. The purpose of this study is to highlight the need to make efficient use of available resources to produce feeds locally by the poultry farmers.

Methodology

This study was conducted in 'Yar-Magaji Community of Bindawa Local Government Area of Katsina State created in 1989 with an estimated projected population of 170,429.1484 as at 2017 at a growth rate of 2.8%. The State is located at latitude $12^0 43'$ north of the equator and longitude $7^0 50'$ east of the Greenwich meridian. It has total area of 398km^2 (154sq mi). Small scale farming is very prominent in the study area though the inhabitants have other sources of livelihood. The major crop that grows in the area are grains crops which include maize, millet, sorghum, cowpea and groundnut. Livestock in the area include cow sheep, goats, chicken and duck. The major language spoken in the area is Hausa and Fulani and majority of the population are farmers. Simple Random sampling method was used to select thirty (30) small scale poultry farmers who were divided in to three groups in 'Yar-Magaji community of Bindawa LGA. A total of 60-day old chicks were used for this study. The birds were fed with starter mash for the first four weeks. After the four weeks the birds were divided into 3 groups with 20 birds per group of poultry farmers. Each group served as a treatment. Group A were fed with solely commercial feed, each member of group B was fed with 20g of sprouted sorghum in addition to commercial feed and each member of group C was fed with 30g of sprouted sorghum daily also in addition to commercial feed for four (4) weeks. Primary data on the farmers were collected using questionnaire.

Analytical Technique

Descriptive statistics and gross margin analysis were used for analysis described below:

The gross margin analysis was employed to compare the profitability of locally sprouted sorghum feed and that of commercial. The model is expressed as

GM = GI - TC

Where

GM = Gross margin

GI = Gross income

TC = Total cost

Results and Discussion

Awareness of Respondents about Feeding Sprouted Sorghum to Broiler Chicken

Awareness is the first stage in the adoption of any innovation among the social community, after identifying the problems facing the poultry farmers in feeding their birds, awareness is created as a way of addressing the farmers' problems in the study area. Vanden Ban and Hawkins (1996) stated that it is easier to change the norms of a group as a whole through demonstration potential users gain experience of new innovation so that they can easily notice and understand it. It is shown on Table 1 that 80 percent of the participants were not aware of the method of sprouting sorghum for poultry feeds whereas only 20 percent were aware. This may be due to poor extension activities in the study area.

Table 1: Awareness of Respondents about Feeding Sprouted Sorghum to Broiler Chicken

Awareness	Frequency	Percentage
Aware	6	20
Not aware	24	80

Level of Feeding Sprouted Sorghum to Broiler Birds before the Introduction

Table 2 shows that none of the farmers in the study area are using sprouted sorghum feed, while 100 percent use commercial feed to feed their poultry. This signifies that the whole poultry farmers in the study area used commercial feed and despite the existence of this innovation. There is hope for the poultry farmers in the study area to expand their stock and production capacity as a result of adoption of the sprouted sorghum poultry feeding.

Table 2: Level of Feeding Sprouted Sorghum to Broiler Birds

Feed Type	Frequency	Percentage
Sprouted Sorghum	0	0.00
Commercial feed	30	100.00

Comparison of Sprouted Sorghum Feeding with Commercial Feed

From the result in Table 3, it could be observed that Group A had an average weight of 1.38kg, Group B had 1.36kg and Group C had 1.40kg weight at week 4. It is observed that there is no difference among the groups which may be due to the same treatment given to them. From the result in Table 3, at week five, it shows that the treatment given has effect on weight gain as broilers fed with commercial feed gain more weight than those fed with 20g and 30g Sprouted sorghum. The recorded average weight was 1.63kg for group A and 1.59kg and 1.57kg respectively for Group B and C given the difference of 0.4 between Group A and B and the difference of 0.2 between Group B and C. This could be due to the fact that the commercial feed is more nutritive and palatable than sprouted sorghum feed. From the result in Table 3 it shows that those fed with commercial feed at week six still gain more weight than those feed with 20g and 30g Sprouted sorghum. The observed differences were 0.9 and 0.1 between Group A and B and Group B and C respectively. From the result obtained at week seven (Table 3), it shows that broiler fed with commercial feed gained more weight (difference of 0.15 between Group A and B) than the broiler fed with sprouted sorghum feed, it might be due to the fact that at this week they eat a lot and feed conversion efficiency is high so that more weight would be gotten unlike those fed with 20g and 30g Sprouted sorghum that their weight gain is not as like that of those fed with commercial feed but they too are gaining good weight (difference of 0.2 between Group B and C) especially when we compare the cost of the feed used. From the result in Table 3 it was observed that the broiler fed with 20g and 30g sprouted sorghum and commercial feed had weight gain differences of 0.22 and 0.3 between Group A and B and between Group B and C respectively at the eight week. Those fed with commercial feed had average weight gain of 2.30kg and those fed with commercial and 20g sprouted sorghum had 2.25kg while those fed with commercial and 30g sprouted sorghum had 2.23kg of average weight gain. This could be due to the fact that, both reach mature stage and hence can be able to take any feed given to them.

Table 3: Weight Comparison among Birds Feed Sprouted Sorghum and Commercial Feed

Week	Group	Average weight
Four	A	1.38
	B	1.36
	C	1.40
Five	A	1.63
	B	1.59
	C	1.57
Six	A	1.89
	B	1.80
	C	1.79
Seven	A	2.15
	B	2.00
	C	1.98
Eight	A	2.40
	B	2.18
	C	2.15

Comparison of Cost and Return Analysis among Broiler Groups

The costs incurred in the broiler production are specified in Table 4. It could be seen that the 60 day-old chicks were purchased at the cost of ₦180 per one to give a total of ₦10,800. The birds were fed 0-4 weeks using the same treatment. About 156kg of starter feed at cost of ₦80 per kg fed to the birds. This gave total of ₦12480. The cost of waterers, feeders, trays, drugs and transportation incurred were ₦3,000, ₦3,000, ₦1200, ₦9,000 and ₦600 respectively. A total sum of ₦40,080 was spent during the first four (4) weeks for all the birds to give ₦13,360 per 20 birds. At the beginning of the fifth week, the birds were divided into three (3) groups (A, B and C). The three groups were each treated separately using different feed levels from week 5-8. Group A were fed with 75kg commercial broiler finisher feed, Group B were fed with 63.8 kg of finisher and 11.2 kg of sprouted sorghum while Group C were fed with 58.2 kg of commercial feed and 16.8 kg of sprouted sorghum. The cost of the finisher was ₦80 per kg while that of the sorghum was ₦100 per kg. Therefore, ₦6,000, ₦6,224 and ₦6,336 were incurred for groups A, B and C respectively between weeks 5 and 8. When this was added to cost in the first four weeks, total cost incurred by each group was ₦19,360, ₦19,584 and ₦19,696 for A, B, and C respectively. For the revenue accrued, birds fed with sprouted sorghum (Groups B and C) attracted higher selling price compared to those fed with solely commercial feed because they are more organic compared to Group A. Thus, the selling price per bird for Group A, B and C were ₦1800, ₦1,900 and ₦1,950 respectively. This gave a revenue of ₦36,000, ₦38,000 and ₦39,000, a gross margin of ₦16,640, ₦18,416 and ₦19,304 and a return per naira invested of 1.86, 1.94 and 1.98 for groups A, B and C respectively. The return implies that for every naira invested in broiler production, a return 86k, 94k and 98k will be realized. This reveals that feeding broiler spouted sorghum while reducing the quantity of commercial feed is more economical especially if the right consumers are targeted because even though they have relatively less weight than those solely fed with commercial feed, they are valued more be the right consumers. The advantage of sprouting sorghum is that sprouted sorghum is more economical and convenient since the sorghum used was readily available in the market and within the locality. It is also easy to make without the use of machine. It also doesn't require or occupies vast land for equipment and machines.

Table 4: Comparison Cost and Return Analysis among Broiler Groups

Cost and Return Components	Quantity			Unit Price (₦)	Total (₦)
0-4 Weeks	Group A	Group B	Group C		
No. of birds	20	20	20	180	10800
Starter mash (kg)	52	52	52	80	12,480
Waterer	2 pcs	2 pcs	2 pcs	500	3,000
Feeder	2 pcs	2 pcs	2 pcs	500	3,000
Tray	1 pc	1 pc	1 pc	400	1,200
Drugs	3 sachets	3 sachets	3 sachets	1000	9,000
Transportation					600
Initial cost (0-4 weeks)	₦13360	₦13360	₦13360		40080
5-8 Weeks					
Finisher (kg)	75	63.8	58.2	80	15,760
Cost of finisher (₦)	6,000	5104	4656		
Fresh sorghum (kg)	-	11.2	16.8	100	
Cost of fresh sorghum (₦)	-	1120	1680		
Finishing cost (5-8 weeks)	6,000	6224	6336		
Total cost (TC)	19,360	19,584	19,696		
Total revenue (TR)	36,000(1800/bird)	38,000(1900/bird)	39,000(1950/bird)		
Gross Income (TR-TC)	₦16,640	₦18,416	₦19,304		
Cost/Naira Invested(TR/TC)	1.86	1.94	1.98		

Conclusion

Based on the results obtained from this work, it shows that the performance of birds fed with sprouted sorghum is almost the same in term of weight gain though the cost of production was slightly higher than that of the commercial feed. The group found that sprouted sorghum feed is more economical and convenient compared to feeding solely commercial poultry feed since the sorghum used is readily available in the market and within the locality. Increased production depends to a large extent on getting the appropriate consumers to buy the birds. Based on the findings of the study, the following recommendations were made:

(i) Poultry business is a capital intensive project and as such Government should provide soft loan and subsidies on vaccine and good stock of day old chicks to the farmers.

(ii) Poultry farmers should be trained on how to sprout sorghum feed and employ an experienced farm attendant for quality labour services. This will go a long way in minimizing the cost of poultry feeds as well as increasing the income of farmers.

(iii) People should be enlightened on the importance of eating poultry that is more organic.

(iv) Poultry farmers should be encouraged to form cooperatives in order to source for assistance from government and individuals.

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Serum Biochemical Characteristics of Rabbit Bucks Fed *Moringa oleifera* Leaf Extract in Water

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Abstract
A 65-day feeding trial was conducted on sixteen (16) rabbit bucks and aged 10–11 weeks to investigate the effect of four levels of Moringa oleifera crude leaf extract (MOCLE) in water on serum biochemical characteristics. Four (4) rabbits each were randomly assigned to 4 treatments in a completely randomized design and each rabbit served as a replicate. The treatment groups each received a basal diet and 4 levels of MOCLE per litre of drinking water and designated as follows: 0 ml (T1), 250 ml (T2), 500 ml (T3) and 750 ml (T4). At the end of the feeding trial, blood samples were collected from the rabbits and evaluated for serum total protein, albumin, globulin, total bilirubin, urea, sodium and potassium. There were no significant (P<0.05) differences across treatments in all the serum biochemical characteristics studied. The values obtained did not conform to the levels of the extract and generally fell within normal ranges reported for healthy rabbits. Therefore it can be concluded that administering MOCLE in drinking water up to 750 ml per litre did not adversely affect blood biochemical characteristics of rabbit bucks.

Introduction
Blood is a complex fliud containing large variety of dissolved, suspended inorganic and organic substances (Stewart, 1991). The primary function of blood is transport of oxygen from respiratory organs to body cells (Duke, 1975), nutrient and enzyme distribution to cells as well as removal of waste products (Baker and Silverton, 1982) thereby maintaining homeostasis of the internal environment (Bentrick, 1974). Blood examinations provide the opportunity to investigate the presence of several metabolites and other constituents that help detect conditions of stress which can be nutritional, environmental or physical (Aderemi, 2004). *Moringa oleifera* Lam. also known as horse raddish, drumstick or ben oil tree belongs to the family *Moringaceae* and it is widely cultivated in many parts of the world. *M. oleifera* has vast medicinal properties as every part is believed to be beneficial (Garima *et al.*, 2011) and serve as a rich repository of proteins, vitamins and minerals (Pandey *et al.*, 2012). The leaf of *M. oleifera* has been used in the form of meals for livestock feeding in the tropics with good results, although, in recent times there is a growing interest in the utilization of its leaf extract. Available literature on serum biochemical investigations involving *M. oleifera* leaf extracts are predominantly on rats with fewer works existing on rabbits. More so, the sohxlet extraction method is widely used for obtaining the various extracts of *M. oleifera* tree but there is a dearth of information on its crude leaf extracts thus prompting this research. Therefore this study sought to evaluate some serum biochemical characteristics of rabbit bucks fed *M. oleifera* crude leaf extracts in drinking water.

Materials and Methods
The experiment was conducted at the rabbitry unit of the Livestock Teaching and Research Farm, Federal University of Agriculture Makurdi, Nigeria. Makurdi is located on latitude 7°45´ N and

longitude 8°31′ E and lies within the Southern guinea savannah. It has two distinct seasons (wet and dry) with annual rainfall range of 508–1016 mm. Temperatures drop as low as 21.6°C in December/January and rise as high as 42.6°C in February/March. Fresh green leaves of *Moringa oleifera* trees was harvested from Wuse village, Azare development area, Awe local government of Nassarawa state, Nigeria based on abundance. The debris-free leaves was obtained and mashed locally without adding water to form a paste. The crude leaf juice was extracted with a muslin (cheese) cloth, refrigerated and used to prepare the final mixtures. A total of sixteen (16) rabbit bucks of mixed crosses, aged 10-11 weeks were used in a 65-day feeding trial. Four rabbits each were randomly allotted to four treatments with each rabbit serving as a replicate. The rabbits were housed singly in wooden and wire mesh hutches, dewormed and adjusted for a period of 2 weeks. The rabbits were fed a basal diet and four levels of *Moringa oleifera* crude leaf extract (MOCLE) at 0 ml, 250 ml, 500 ml and 750 ml per litre of drinking water, designated as T1 (control), T2, T3, and T4 respectively. At the end of the 65-day feeding trial, 16 rabbits (4 rabbits per treatment) were sacrificed and about 10 ml each of blood was separately collected into sterile sample tubes without an anticoagulant for the determination of serum biochemical characteristics (total protein, albumin, globulin, total bilirubin, urea, potassium, sodium, calcium and phosphorus). Total protein and albumin was determined according to Tietz (1976) and Grant *et al.* (1987) respectively while globulin was determined by difference of total protein and albumin. Total bilirubin investigation was done using the method of Sherlock (1951) while urea, sodium and potassium were determined using the Erba Mannheim® Chem5Z3 digital blood biochemistry analyzer. Data were subjected to one-way analysis of variance (ANOVA) using IBM SPSS® (2011) version 20. Significant means ($P<0.05$) was separated using Duncan of the statistical software.

Results and Discussion

The serum biochemical characteristics of rabbits in this study did not differ significantly as a result of the inclusion of levels of MOLE. Blood chemistry constituents reflect the physiological responsiveness of the animal to its internal and external environments which is inclusive of feeds and feeding (Iheukwumere and Okoli, 2002). Serum total protein is an indirect index of for measuring nutritional protein adequacy (Eggum, 1970a). Hawkey *et al.* (2000) opined that high total protein values signified better protein content of a test feed. The total protein range of 67.50 to 73.0 g/L from this study was not significant and did not conform to the levels of the extract. The total protein values occurred within normal range (28 – 100 g/L) reported by Flecknell (2000), however, the values were higher than the 51.0 – 69.0 g/L (converted) observed from the findings of Nuhu (2010) who replaced SBM with MOLM at 0, 5, 10, 15 and 20 % levels respectively in diets of rabbits. These finding indicate that MOLE supplied adequate proteins which supported growth and normal blood functions. Albumin investigations showed statistical similarities across treatments with values ranging from 47.25 to 56.25 g/L which followed the same trend as total protein. Albumin is quantitatively the most important liver protein as it serves as a useful indicator of hepatic function (Thapa and Walia, 2007), and it is a major transport protein in the blood due to its enhancement of plasma osmotic pressure (Brar *et al.*, 2011). Albumin values in this current work was higher than the 32 to 41 g/L (converted) found by Nuhu (2010). However, the values fell within the normal range (30 to 50 g/L) for rabbits reported by Flecknell (2000) with the exception of T3 (56.25 g/L) and T4 (52.00 g/L) that were slightly above normal. Orhue *et al*. (2005) stated that decrease in albumin could be due to reductions in liver protein synthesis, increased protein losses in gut and kidney, and malabsorption. Therefore, the normal albumin values of the rabbits imply that the levels of MOLE did not result to reductions in liver protein synthesis or adverse protein losses. Globulin values (16.25 to 23.75 g/L) were also statistically similar across treatments and occurred within the normal range of 15 to 27 g/L (converted) for rabbits reported by Flecknell (2000). This result was comparable to the range of 19.0 to 28.0 g/L observed by Nuhu (2010) who replaced SBM with MOLM in the diet of rabbits. Eggum (1970b) and Hawkey *et al*. (2000) stated that high serum globulin level corresponds with the ability of the body to fight diseases. This implies that the inclusion of MOLE in drinking water of rabbits did not impair normal functioning of this salt soluble protein. Bilirubin is a diagnostic marker for liver and blood disorders and elevated bilirubin formation can occur during abnormally high breakdown in peripheral haemoglobin i.e. haemolysis (Fevery, 2008). In addition total and conjugated bilirubins are indicators of protein adequacy (Ahemefule *et al*., 2008). Total bilirubin (0.25 to 0.42 mg/dL) recorded in this study did not differ significantly ($P < 0.05$) and was within the standard range (0 to 1.0 mg/dL) for healthy rabbits reported by Smith (2003). This result suggests that the administration of MOLE to rabbits did not disrupt liver function which probably enhanced the availability of sufficient nutrients needed to support basic body maintenance. The result for blood urea concentration (9.48 to 12.10 mmol/L) obtained in this current work followed the same pattern as that of total bilirubin and was within the normal range of 9.3 to 25.5 mmol/L for rabbits as reported and cited by Flecknell (2000). Urea is a product of general cellular metabolism and it is a general marker of renal function (Basten, 2010). Abnormally elevated blood levels are associated with poor protein quality (Eggum, 1970a) or excess tissue catabolism associated with protein deficiency (Oduye and Adadevoh, 1976) while abnormally low blood urea indicates hepatic dysfunction (Varga, 2013). The non-significantly ($P < 0.05$) different and normal blood urea concentrations in this study implies that the composite dietary protein supplied by MOLE and the basal diet was adequately utilized by the body of the rabbits. Sodium is the chief extracellular cation that exists in body fluids as free ions in maintaining cellular tonicity, fluid balance, pH and regulation of neural and muscular functions (Cheesbrough, 2000). The statistical similarity ($P > 0.05$) in sodium values (132.00 to 140.50 mmolL) obtained from this research were within the standard reference range of 130 to 155 mmol/L for healthy rabbits observed by Flecknell (2000). The abnormal increase in blood sodium results in body water retention and a consequent reduction in sodium concentration (Prohp and Onoagbe, 2014); blood pressure which is partly dependent on blood volume thereby rises with increased body water retention (Kruetler, 1980). Therefore, this result suggests that the supplement feeding of MOLE did not likely impair the osmotic as well as blood pressure functions of the rabbits. Serum potassium was not adversely affected ($P > 0.05$) by the levels of MOLE and values were within the normal range (3.50 to 7.00 mmol/L) indicated by Varga (2013). Potassium is the abundant cation in the intracellular fluid compartment. Prohp and Onoagbe (2014) reported that hyperkalaemia was associated with renal failure due to the inability of the kidney to excrete potassium. In addition, severe dehydration and renal dysfunction triggers elevations in blood potassium could give rise to muscle weakness, cardiac arrthmia and consequently heart failure (Abubakar and Sule, 2010). Therefore, the normality in the potassium values from this work suggests that renal functioning of the rabbits was not impaired by feeding MOCLE.

Conclusion

The serum biochemical characteristics of the rabbits investigated did not incur outstanding differences irrespective of the levels of MOCLE and the values generally fell within normal ranges for healthy rabbits. The supplemental feeding of MOLE of up to 750 ml in the drinking water of rabbits is highly tolerated without adverse effect on serum characteristics.

Table 1: Proximate composition of basal diet (calculated)

	Nutrient					Digestible energy (kcal/kg)
	Crude protein	Crude fibre	Crude fat	Ash	Nitrogen free extract	
% Composition	16.00	10.04	7.85	5.95	60.17	2822.5

Ingridients: maize 44.1 %, full fat soya bean 23.9 %, rice offal 20.0 %, palm kernel cake 9.5 %, bone ash 2.0 %, table salt 0.3 %, *vitamin premix 0.2 %. * BIOMIX ® GROWER at 0.2 % supplied the following: vitamin A (retinol) 640000 IU; vitamin B_1(thiamine) 160 mg; vitamin B_2 (riboflavin) 200 mg; vitamin B_3 (niacin) 1200 mg; vitamin B5 (pantothenic acid) 440 mg; vitamin B6 (pyridoxine) 160 mg; vitamin B8 (biotin) 20 mg; vitamin B9 (folic acid) 40 mg; vitamin B12 (cobalamin) 0.8 mg; D_3 120000 IU; vitamin E (tocopherol) 560 mg; vitamin K_3 120 mg; Choline

Chloride 14000 mg; Cobalt 16 mg; Copper 240 mg; Iodine 80 mg; Iron 1680 mg; Manganese 3200 mg; Selenium 160 mg; Zinc 2480 mg; and antioxidant 100 mg.

Table 2: Serum biochemical characteristics of rabbit bucks fed *Moringa oleifera* crude leaf extract

Blood characteristics	Levels of extract in water				± SE	P-value
	T_1 0 ml/L	T_2 250 ml/L	T_3 500 ml/L	T_4 750 ml/L		
Total protein (g/l)	71.75	67.50	72.50	73.00	1.54	0.619^{ns}
Albumin (g/l)	48.00	47.25	56.25	52.00	1.96	0.370^{ns}
Globulin (g/l)	23.75	20.25	16.25	21.00	2.34	0.767^{ns}
Total bilirubin (mg/dl)	0.30	0.25	0.35	0.42	0.03	0.288^{ns}
Urea (mmol/l)	12.10	11.12	11.46	9.48	0.97	0.830^{ns}
Sodium (mmol/l)	132.00	151.00	135.50	140.50	2.71	0.051^{ns}
Potassium (mmol/l)	6.74	4.54	5.03	5.90	0.43	0.296^{ns}

^{ns} not significant (P > 0.05)   SE standard error

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Serum-Biochemical Trait of Growing Exotic and Indigenous Turkeys as Influence by Specific Genes

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Abstract
The aim of this preliminary study was to establish reference normal ranges of biochemical parameters in different breeds of turkeys in the Teaching and Research Farm, Faculty of Agriculture, Ambrose Alli University, Ekpoma, Edo state, Nigeria. The animals were monitored during a 4 month period (16weeks). Blood samples, collected from growing turkeys for laboratory analysis. Serum-biochemical parameters evaluated in the blood samples of the birds were significant ($P<0.05$) differences between genotypes in Total protein, Albumin, Globulin, Cholesterol and Glucose. Local white genotype however, had the highest significant Total protein (5.70ml), Albumin (2.67 ml) Globulin (3.03ml) and Glucose (133.83m/dl) compared to other turkey genotypes. Results indicated that biochemical data were comparable to those described in turkeys. Results on blood chemistry of turkey genotypes could be used in the classification of turkeys into genetic groups and can be utilized in crossbreeding programmes to produce crossbreds that are highly productive and adapted to the environment.

Introduction
Publications on the serum-biochemical of turkeys have not been properly reported domestic or wild turkey from different geographical and Agricultural zone of the world (Warren, 1995 and Bonous *et al* 2000). Serum biochemical values have been established in most domestic avian species (Jain, 1986 and Adejumo *et al*., 2005). Turkeys (*Meleagris gallopavo*) are reared all over the world for their tasty and high quality meat. It originates from North America and has been introduced nearly worldwide including Nigeria. Though the turkey posses the ability to acclimatize in various types of climate, are very much sensitive to sudden climatic changes during the early life. Physiological tolerance of organisms is strong determinant of the environmental conditions in which they inhabit. Phenotypic Characterization could also be supported by genotype identification through laboratory study of gene markers or biochemical polymorphisms (LE-Gall *et al*., 1994). The reference value presented for biochemical values could significantly boost genetic improvement and base line information.

Materials and Methods
Study area
The research was carried out at the Poultry Unit of the Livestock Teaching and Research Farm of Ambrose Alli University Ekpoma, Edo State. The farm lies between Lat 6.44^{o}N and Log 6.8^{o}E in Esan West Local Government Area of Edo State, Nigeria. Ekpoma is within the South-South geo-political zone of Nigeria and has a prevailing tropical climate with a mean annual rainfall of about 1556mm. The mean ambient temperature ranges from 26^{0}C in December to 34^{0}C in February, relative humidity ranges from 61% in January to 92% in August with yearly average of about 82%. The vegetation represents an interface between the tropical rainforest and the derived savanna.

Management of the birds
A total of 60 growing Turkeys were used for this study. These consisted of 15 birds each of Genotype Exotic, Local white, Lavender and Local Black respectively. All birds were wing tagged for proper identification and subjected to the same management practice throughout the experimental period. Medication and vaccinations were carried out accordingly against stress and disease.
Feeds and Feeding
The birds were fed *adlibitum* with starter marsh containing 20% crude protein, 2996Kcal/kg Metabolizable Energy from Dayold-4weeks of age, Broilers finisher's diets containing 15.86% crude protein, 2716Kcal/kg Metabolizable Energy was fed from 4-16weeks of age. Clean water was supplied continuously *adlibitum* throughout the experimental period.
Sample Collection
Blood sample were collected from the jugular veins using sterile disposable needles (21-guage) and syringes. Before the blood collection, the birds were fasted over night for 12 hours and samples were collected the following morning to avoid excessive bleeding. Samples for biochemical indices analysis were collected into anti-coagulant free tubes and allowed to clot. Serum was obtained after the blood samples had been allowed to stand for two hours at room temperature and centrifuged for ten minutes at 2000.rpm to separate the cell from the serum.
Experimental design and statistical analyses
All data obtained were subjected to analysis of variance to investigate the effect of strain on haematological and serum biochemistry, using the General Linear Model of SAS (1999). Duncan's Multiple Range Test was used to separate the means that are significantly difference (Gomez and Gomez, 1984).

$\mathbf{Y_{ij} = \mu + T_j + \sum_{ij}}$
where Y_{ij} = Observed value of dependent variable
μ = Population mean
T_i = i^{th} fixed effect due to Genotype (= 1…4)
$\sum_{ij}$ = Random residual error.

Results and Discussion
Regarding the analyzed blood parameters of turkey the specific genetic variation was an important source of variability for Total protein, albumen, globulin glucose, cholesterol, urea and Creatinine were significantly ($p<0.05$) affected by genotypes. Local Black genotype however, had the highest significant Total protein (5.70ml), Albumin (2.67 ml) Globulin (3.03ml) and Glucose (133.83m/dl) compared to other turkey genotypes. These findings agree with those reported by Ibrahim *et al* (2012) and Isidahomen *et al* (2013). The increase in protein concentration in blood is partially contributed to raised albumin concentration but mainly due to increase in the globulin concentration during the cold stress. The increase in the albumin concentration might be due to effect of cortisol activity because increased cortisol level has catabolic action on muscles, lymphatic tissue and bone (Eiler, 2004).The comparison of the blood parameters of the analyzed local and pure breed turkeys show explicitly serum biochemical is strongly genetically determined. In this study, however, of fundamental significance is the comparison of results obtained for turkey breeds.

Table 1: Serum-Biochemical Parameters of Exotic and Indigenous Turkeys as Influence by Specific Genes

Parameters	Exotic	Local White	Lavender	Local Black
Total Protein (ml)	4.70 ± 0.10^{b}	4.33 ± 0.15^{c}	4.87 ± 0.06^{b}	5.70 ± 0.11^{a}
Albumin (ml)	2.30 ± 0.04^{b}	2.55 ± 0.07^{a}	2.60 ± 0.06^{a}	2.67 ± 0.08^{a}
Globulin (ml)	2.23 ± 0.04^{b}	1.73 ± 0.06^{c}	2.27 ± 0.08^{b}	3.03 ± 0.09^{a}
Glucose (m/dl)	127.17 ± 4.12^{ab}	123.33 ± 1.31^{bc}	118.17 ± 1.11^{c}	133.83 ± 2.01^{a}
Cholesterol (m/dl)	96.83 ± 2.55^{a}	83.67 ± 2.09^{b}	95.00 ± 3.32^{a}	94.83 ± 1.28^{a}
Urea(ml)	4.33 ± 0.21^{b}	6.17 ± 0.40^{a}	6.80 ± 0.20^{a}	6.17 ± 0.40a
Creatinine (ml)	0.72 ± 0.04^{ab}	0.63 ± 0.04^{b}	0.77 ± 0.04^{a}	0.77 ± 0.04^{a}

a,b,c; Means in the same row with different superscript are significantly different ($P<0.05$)

Conclusion

According to the results of current experiment, it was found that the four analyzed genetic groups of turkeys exhibited a response to genotype and could be considered as preliminary reference values which are particularly important for turkey diagnosis and breeding. Further it is evident from the study that birds can also thrive well in the humid environment of Nigerian.

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Efficiency of Feed Utilization by Pure and Crossbred Turkeys in Southwestern Nigeria

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Abstract

One hundred and twenty poults comprising sixty, each of indigenous and crossbred were used to evaluate the differences in body weight and feed efficiency between indigenous and crossbred turkey genotypes. Feed intake, body weight and feed efficiency were recorded at 2, 4, 8, 12, 16 and 20 weeks of age. The results of this study showed that body weight had significant (P<0.05) effect on genotype only at 20 weeks of age. However, the crossbred poults consistently had higher least square means value of body weight throughout the experiment. Conversely, significant sexual dimorphism was observed in all the weeks except at 2 weeks of age, with male having higher means value in all the weeks of the experiment. Furthermore, genotype had significant effect (P<0.05) on feed intake in all the weeks of the experiment except at 2 weeks of age. The crossbred consumed more feeds when compared to their indigenous counterpart. More so, the feed efficiency was significantly influenced (P<0.05) by genotype at 4, 8 and 12 with indigenous turkey had higher efficiency of feed utilization in all the weeks of the experiment. It was concluded that superiority in body weight exhibited by crossbred genotype and better feed efficiency displayed by the indigenous turkey suggested that the crossbred took the advantage of the heterosis of the indigenous and exotic parents and can be further improved upon to show superior quality in most of the productive and adaptive traits than their exotic and indigenous parents. The indigenous on the other hand effectively utilized the feed consumed indicating opportunities for improvement

Introduction

Turkey (Meleagris gallopavo) production is an aspect of poultry industry which is not popular in Nigeria until last decade. Turkey production is now carried out in all parts of the country in Nigeria but at a very low scale (Maikasuwa *et al.,* 2014). Most of the turkeys reared in Nigeria are indigenous breeds with only few exotic breeds (such as Nicholas white, Kelly and British United) and their crosses. Several researches on turkey production in the past have been directed toward improving exotic turkeys with the aim of improving percent breast meat, feed efficiency, fecundity, livability among other performance characteristics. Generally, Nigeria indigenous turkeys are very hardy, tolerant to most of the diseases of turkey in temperate region, can survive on low nutrient feed resources and best adapted to prevailing tropical climatic conditions. These birds are nondescript with multi-colored plumage and sometimes appearing as pure black or white. The productivity of indigenous turkeys can be improved by crossbreeding exotic Toms, having superior genetic make-up with indigenous hens. It was stated in Adebambo *et al.* (2006) that the controlled introduction of new and improved genetic materials into indigenous breeds of bird is expected to speed up genetic progress through the exploitation of hybrid vigour. There is need therefore to compare the productivity of indigenous and crossbred turkeys in terms of feed efficiency and reproductive performance. This will help to justify the need to improve indigenous turkeys using exotic genetic makeup. The objective of this study was therefore to evaluate genetic variation in body weight and feed efficiency of indigenous and crossbred turkeys in Nigeria.

Materials and Methods

Study area: This research work was carried out at the Turkey Breeding unit of the Teaching and Research Farm of the College of Animal Science and Livestock Production (COLANIM), Federal University of Agriculture, Alabata road, Abeokuta, Ogun state Nigeria. The studied area was described by Ilori *et al.*(2010).

The Management of experimental birds: The birds used for this experiment include; two genotypes of day old poults comprising sixty indigenous and sixty crossbred breed generated from mating exotic toms with indigenous hens. The birds were raised under intensive system of management. The toms and hens were housed separately on deep litter. Feed and water were provided *ad libitum*. They were being fed commercial feed and clean water *ad libitum*. Starter diets of 28% crude protein (CP), grower mash of 24% CP and finisher mash of 20% CP were provided for the birds from 0-6 weeks, 7-16 weeks and 17-20 weeks of age respectively. The birds were vaccinated against marek, Newcastle and fowl pox diseases and administered antibiotic and anticoccidial prophylactically. They were placed initially on grower mash and provided with breeder mash after they attained 10% egg production. The birds were wing tagged for proper identification. Body weights were taken weekly on the poults of the two genetic groups from day old to 20 weeks of age. Feed intake was recorded on daily basis while feed efficiency was computed for the two genetic groups throughout the experiment. The two genotypes were reared differently but under the same management system.

Experimental design and statistical analyses: Data obtained were analyzed using General Linear Model of SAS(1999). The model used is as follows:

$Y_{ijk} = \mu + G_i + S_j + (GS)_{ij} + e_{ijk}$

Where

Y_{ijk} = The parameter of interest, μ = overall mean for parameter of interest, G_i= effect of the i^{th}sire genotype (i= 1,2), S_j = effect of j^{th}sex (J = male, female), $(GS)_{ij}$ = effect of the interaction of the genotype and sex while e_{ijk} = random residual error.

New Duncan's Multiple Range Test (Duncan, 2005) was used to separate means which were significant.

Results and Discussion

Body Weight: The analyses of variance for body weight (BW), Sex, feed intake and feed efficiency showed that genotype had significant effect (P<0.05) as shown in table below.

Table 1: Least square means of body weight (g) as affected by genotype and sex

Age in weeks	Genotype		Sex	
	Indigenous	Crossbred	Male	Female
0	44.27 ± 0.62^a	44.32 ± 0.58^a		
2	85.68 ± 15.33^a	94.51 ± 2.33^a	96.41 ± 15.25^a	71.68 ± 1.96^a
4	299.78 ± 7.28^a	338.46 ± 9.96^a	333.23 ± 8.87^a	297.83 ± 7.99^b
8	991.54 ± 21.69^a	1007.13 ± 31.96^a	1060.58 ± 24.62^a	904.64 ± 20.69^b
12	1743.00 ± 38.50^a	1840.42 ± 36.91^a	1844.97 ± 35.91^a	1591.33 ± 29.47^b
16	2302.56 ± 45.78^a	2479.91 ± 43.42^a	2487.47 ± 40.77^a	2223.81 ± 47.57^b
20	2869.68 ± 46.08^b	3330.79 ± 34.01^a	3155.57 ± 44.25^a	2907.86 ± 60.81^b

Within variable grouping, means in the same row with different superscripts are significantly different (P<0.05)

Table 2: The least square means of the effect of genotype on feed intake (g/day)and feed efficiency

Age in weeks	Genotype			
	Feed intake		Feed efficiency	
	Indigenous	**Crossbred**	**Indigenous**	**Crossbred**
2	10.73±1.05[a]	14.13±2.02[a]	0.57±0.06[a]	0.43±0.05[b]
4	31.93±2.78[b]	65.20±10.77[a]	0.50±0.05[a]	0.26±0.05[b]
8	87.39±6.73[b]	136.53±34.82[a]	0.33±0.03[b]	0.27±0.07[b]
12	131.83±16.79[b]	212.02±28.31[a]	0.21±0.03[a]	0.13±0.02[b]
16	190.03±15.03[b]	281.40±40.02[a]	0.12±0.01[a]	0.10±0.01[a]
20	225.66±14.26[b]	343.99±40.64[a]	0.11±0.01[a]	0.11±0.01[a]

Means in the same row with different superscripts are significantly different (P<0.05)

At 20 weeks, the crossbred turkey had superior values in body weight in all the weeks of the experiment suggested that crossbred turkey had a better growth potential than its indigenous counterpart. This agreed with the findings of Ilori *et al.* (2010) who reported that exotic turkey had superior body weight than the crossbred turkey. This was due to the fact that the crossbred utilized the advantage of higher growth rate derived from exotic parent to achieve improved body weight. This further proves that the crossbred is able to transmit the gene for faster growth to its progeny (Ilori *et al.,* 2010) Though o ur indigenous poultry have gone through more of natural selection for adaptation and survival to the tropical climate rather than artificial selection for productivity. The sexual dimorphism exhibited on growth by each genotype in this study agreed with the findings of earlier documented (Hancock *et al.,* 1994 and Deeb and Cahaner, 2001). The above authors opined that males consistently had higher mean values than females and this was attributed to the differences in hormonal profile, aggressiveness and dominance of the males when feeding (Ibe and Nwosu, 1999).The results on feed intake and feed efficiency showed that genotype was affected in the experiment. This result agreed to the findings of Ilori *et al.* (2010), who reported that the crossbred consumed more feed on the average than exotic and local turkeys.This may be due to the fact that they combined the genetic make-up of both the indigenous and the exotic turkey in terms of feed intake. Ayorinde and Oke (1995) reported that the quantity of feed consumed in kilograms by different strains differed as well as the efficiency in converting the feed to flesh.

Conclusion

Differences in body weight, feed intake and feed efficiency observed between the two genotypes could be attributed to differences in their genetic makeup. This suggested that the crossbred turkeys can be further improved to a stage where it will have superior quality in most productive and adaptive traits than their indigenous and exotic parents.

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Health Status of Ducks Fed Fermented Cassava Root-Leaf Meal Blend as a Replacement For Maize

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Abstract
Diet is an integral aspect of animal growth and development, adequate amount of needed amino acids must be properly inculcated. This study was conducted to evaluate health status of ducks fed fermented cassava root-leaf meal blend as a replacement for maize. One hundred and fifty, day old unsexed Mallard ducklings was used for the experiment. Ducklings were randomly distributed into 5 groups of 30 ducklings per treatment. Each treatment was further subdivided into 3 replicates with 10 ducklings per replicate in complete randomized design (CRD). The study is made up of 5 dietary treatments consisting of control (Treatment 1), fermented cassava root-leaf blend used to replace maize at 25% (Treatment 2), 50% (Treatment 3), 75% (Treatment 4) and 100% (Treatment 5) levels respectively. The PCV and Hb levels increased as FCRLM inclusion increased in the diet. RBC values recorded increased with increased in dietary inclusion of FCRLM. The result of the hematological parameters revealed that The RBC, Hb, RBC and WBC all showed reference values. However, WBC values recorded were higher than reference values for the species used in this study. Increased in FCRLM led to decreased in blood cholesterol level

Keywords: Ducks, cassava root- leaf meal blend, fermentation, haematology and serum

Introduction
Diet needed for survival of animals and humans due to its basic function in nutrition to supply adequate amount of needed amino acids must be properly addressed (Owosibo and Longe 2007). Dietary components affect the blood profile of healthy birds (Iheukwumere and Herbert, 2012). It is often very difficult to assess the current health status of animals without detailed examination of blood (Amakiri et al., 2009). Examination of blood provides the opportunity to clinically investigate the presence of several metabolites and other constituents in the body and it plays a vital role in the physiological, nutritional and pathological status of the animal (Aderemi, 2004; Doyle and Williams, 2006). The haematological examination is among the methods which may contribute to the detection of some changes in health and physiological status, which not be apparent during physical examination but which affects the fitness of the animal (Bamishaiye et al., 2009).They are good indicators of the physiological status of animals (Adenkola and Durutoye, 2004; Adenkola et al., 2008) and it changes are of value in assessing the response of animals to various physiological situations and disease conditions(Schalm et al., 1975). Evaluation and interpretation of the results obtained are dependent on the reference values for each animal species, in those regions under existing environmental conditions (Otto et al., 2000) which are used as reference point for comparing and interpretation of metabolic state or condition of animals (Babatunde et al., 1992). In Nigeria, due to the scarcity and high cost of conventional ingredients, there is a renewed interest in the use of non-conventional cheap and easily available ingredients in feeding birds. Cassava products have been in use for a long time as an energy source in place of cereal grains for livestock (Eruvbetine et al., 2003) but limited by its high fibre content, low protein value and hydro-cyanic acid which is deleterious to

animal growth and development (Tewe and Iyayi, 1989; Panigrahi ,1996; Yeoh and Yruong, 1993). The inclusion of leaf meal in poultry nutrition serves as sources of proteins, vitamins, minerals and carotenoids at a relatively reduced cost (D'Mello *et al*., 1987; Opara, 1996) and fermentation has been employed to break down fibrous feedstuffs and reduce toxicity of hydrocyanide in cassava leading to nutritionally enriched product due to the increase in growth and proliferation of fungi or bacterial complex in the form of single cell proteins (Antai and Mbongo, 1994; Oboh, 2002) are approaches to alleviate major constraints to cassava utilization in poultry. Therefore, evaluating the nutritional and potential of wholesome mixtures of the three waste materials with the aim of replacing and serving as an input in animal feedstuff production was inevitable. This study was aimed at determining the level of the fermented cassava root leaf meal that ducks can tolerate when included in their diet without detrimental effect on their health status.

Materials and Methods

Experimental site: The project was carried out at the Teaching and Research farm of Yaba College of Technology Epe Lagos State. It is situated at latitude 6.58ºN, Longitude 3.98ºE. It is 42m above the sea level along the Epe- Ijebu Ode road. Epe lies in the low land rain forest, vegetation zone within the savannah agro ecological zones of south Nigeria (Google earth, 2015).
Cassava root- leaf meal processing: Fresh cassava root tubers (TMS30572) were harvested, washed and grated. The cassava leaves were harvested and chopped into smaller pieces using kitchen knife. A maize-soybean diet was formulated as control. Fresh grated cassava root and leaves was mixed at a ratio of 1kg cassava root meal with 300g cassava leaves, fermented for 5 days under an air-tight environment, air dried (for 2-3 days) and used to replace maize at varying proportions in the basal diet. Products obtained at the expiration of the fermentation were analysed for proximate composition using the standard methods of (AOAC, 2002) and gross energy (Adiabatic Bomb Calorimeter).

Experimental Birds, Management and Design

One hundred and fifty, one-day old unsexed Mallard ducklings was distributed randomly into 5 groups of 30 ducklings per treatment. Each treatment was further subdivided into 3 replicates with 10 ducklings per replicate in complete randomized design (CRD). The study is made up of 5 dietary treatments consisting of control (Treatment 1), fermented cassava root-leaf blend used to replace maize at 25% (Treatment 2), 50% (Treatment 3), 75% (Treatment 4) and 100% (Treatment 5) levels, respectively. Diets were formulated to meet the NRC (1994) requirements. The ducklings were raised on deep litter in an open sided deep litter house. Feed were offered *ad libtum.* The study was conducted for a period of 6 weeks.

Data Collection

Measurement of haematological indices
Blood samples meant for haematological indices analysis were collected from ducks at 42 days from 6 birds per treatment through wing vein using sterilized syringe. 2.5ml blood was collected from each bird into vials containing ethytlene diamine tetra-acetic acid(EDTA)as anticoagulant and used for the following hematological determinations: packed cell volume (PCV), red blood cell count (RBC), haemoglobin concentration (Hb), total white blood cell count (WBC), and percentage distribution of white blood cells (differential leukocyte count) using standard techniques (Schalms *et* al*.,* 1975; Coles, 1986).

Measurement of serum metabolites
Blood samples were collected from ducks at 42 days from 6 birds per treatment through wing vein using sterilized syringe. 2.5ml blood was collected from each bird into vials without anticoagulants were ***allowed to clot. The serum from the clotted blood samples were used to determine Total serum protein (TSP),Serum albumin (SA),Serum globulin (SG),Serum uric acid (SUA), Serum creatinine (SC),Serum glucose (SG),Serum enzyme activity (ALT and AST). The total serum protein was determined according to the method of Colowick***

and Kaplan (1955),while serum albumin and globulin were determined using bromocresol purple method of Varley **et al*****.(1980). Serum creatinine was determined using the principle of Jaffe reaction as described by Bousnes and Tauslay (1945) while the serum uric acid was determined by the kit (Quinica Clinica Spam) (Wooton, 1964). Serum glucose was determined colorimetrically using the method described by Braham and Trinder (1972). Serum cholesterol was determined by enzymatic end point method as described by Roeschlau et al. (1974) while serum enzyme activity was determined using the colorimetric method.***

Result and Discussion

The proximate composition of fermented cassava root- leaf meal as shown in Table 1. The result of haematological parameters in Table 2 revealed that RBC, Hb, and WBC were significantly different. PCV and Hb levels increased as FCRLM inclusion increased in the diet. RBC values recorded increased with increased in dietary inclusion of FCRLM but lower than the the proximate composition of fermented cassava root-leaf meal is as shown in Table 1. The result of the haematological parameters (Table 2) revealed that The RBC, Hb, RBC and WBC all showed reference values. However, WBC values recorded were higher than reference values for the species used in this study. The blood parameters are good indicators of physiological, pathological and nutritional status of an animal and changes in values have the potential of being used to elucidate the impact of nutritional factors. This is supported by previous work that RBC, Hb and other parameters vary among bird species and are affected by diet contents (Odunsi *et al*., 1999; Kurtoglu *et al*., 2005). According to Peters et al.,2011), previous reports stated that Packed Cell Volume, haemoglobin and mean corpuscular haemoglobin are major indices for evaluating circulatory erythrocytes, and are significant in the diagnosis of anaemia and also serve as useful indices of the bone marrow capacity to produce red blood cells as in mammals (Awodi et al., 2005; Chineke *et al.,* 2006). Furthermore, Chineke *et al.* (2006) posited that high Packed Cell Volume (PCV) reading indicated either an increase in number of Red Blood Cells (RBCs) or reduction in circulating plasma volume. Table 3, showed that FCRLM at 50% inclusion on serum metabolites like protein, globulin, albumin, uric acid, creatinine, triglyceride, cholesterol, AST and ALT significantly affected the values. A slight decrease was observed in protein, globulin, albumin, uric acid values with increase in the inclusion of test ingredient. The observed decrease in cholesterol level with increase in the FCRLM inclusion could be linked bio active compounds like flavonoid, tannins and saponins present in cassava leaves which prevents LDL oxidation and decreases cholesterol and triglycerides (Sallappan and Akoh, 2002). Also saponin is able to lower biosynthesis of exogenous cholesterol by tying up bile salts and cholesterol in intestine which reduces cholesterol in the blood(Oyewole and Akingbala, 2011).

Conclusion

It can be concluded based on findings of this study that cassava root when fermented with cassava leaves (at 300g/kg leaf- root) can successfully replace maize up to 50% replacement will enhance better blood circulation and health status of ducklings

Table 1: percentage composition of the experimental diet (duck starter 0-42days)

Ingredients	T1	T2	T3	T4	T5	FCRLM
Maize	54.00	40.50	27.00	13.50	0.00	
Palm oil	1.00	1.00	1.00	1.00	1.00	
Soybean meal	30.00	30.00	30.00	30.00	30.00	
FCRLM	0.00	13.50	27.00	40.50	54.00	
Wheat offal	6.00	6.00	6.00	6.00	6.00	
Fish meal	3.00	3.00	3.00	3.00	3.00	
Bone meal	3.00	3.00	3.00	3.00	3.00	
Lime stone	2.00	2.00	2.00	2.00	2.00	
Lysine	0.25	0.25	0.25	0.25	0.25	
Methionine	0.20	0.20	0.20	0.20	0.20	
Salt	0.25	0.25	0.25	0.25	0.25	
Premix	0.30	0.30	0.30	0.30	0.30	
Total	100.00	100.00	100.00	100.00	100.00	
Calculated Analysis						
Crude protein (%)	21.30	21.34	21.38	21.41	21.46	9.76
Crude fibre (%)	4.25	3.98	3.71	3.44	3.71	3.84
Calcium (%)	1.19	1.19	1.19	1.19	1.19	-
Phosphorus (%)	0.65	0.65	0.62	0.61	0.60	-
Energy (kcal/kg)	2864	2827	2870	2913	2956	3560

Starter premix: - Vit. A 8, 500,000 (iu), Vit D3 1,500,000 (iu), Vit. E 10,000(mg), Vit K3 1,500 (mg), Vit B1 1,600 (mg), Vit. B2 4,000 (mg),Niacin 20,000 mg, Pantothenic acid 5,000mg, Vit. D6 1,500mg, Vit.B12 10mg, Folic acid 500mg, Biotin H2 750mg, Chlorine chloride 175,000mg,Cobalt 200mg, Copper 3,000mg, Iodine 1,000mg, Iron 20,000mg, Manganese 40,000(mg), Selenium 200mg, Zinc 30,000mg, Anti-oxidant 1,250mg.
T1(0% replacement level), T2 (25% replacement level), T3 (50%replacement level),T4 (75% replacement level), T5 (100% replacement level). FCRLM- Fermented cassava root leaf meal.

Table 2: Haematological indices of ducks fed fermented cassava root-leaf meal

Parameters	T1	T2	T3	T4	T5	SEM
PCV (%)	26.50^c	32.00^b	38.00^a	38.33^a	32.00^b	1.21
Hb(g/dl)	9.35^b	10.56^b	13.18^a	14.07^a	10.37^b	0.53
RBC($\times10^{12}$mil/mm^3)	1.92^d	2.30b^c	2.67^a	2.49^{ab}	2.17c	0.07
WBC(no/mm^3)	10.73^b	10.98^b	12.17^a	11.57^{ab}	11.07^b	0.17
Heterophil(%)	36.33	39.67	36.00	37.00	36.67	0.74
Lymphocyte(%)	60.00	59.00	58.00	56.33	57.33	0.97
Monocyte(%)	1.33	1.00	0.00	0.66	0.66	0.14
Basophil(%)	2.67	3.33	3.00	3.33	3.33	0.22
Eosophil(%)	0.00	0.00	0.00	0.00	0.00	0.00

abcd Means in the same column with different superscripts were significantly ($p<0.05$) different.
T1(0% replacement level), T2 (25% replacement level), T3 (50%replacement level), T4 (75% replacement level), T5 (100% replacement level).

Table 3: Serum indices of ducks fed fermented cassava root-leaf meal as maize

Parameter	T1	T2	T3	T4	T5	SEM
Total Protein (mg/dl)	5.60^{a}	5.70^{a}	4.48^{b}	4.46^{b}	4.24^{b}	0.17
Globulin(mg/dl)	2.18^{bc}	3.11^{a}	2.50^{b}	1.96^{bc}	1.85^{c}	0.13
Albumin(mg/dl)	3.42^{a}	2.79^{b}	2.51^{b}	2.50^{b}	2.35^{bc}	0.13
Uric acid(mg/dl)	5.30^{a}	4.93^{ab}	4.69^{ab}	4.53^{ab}	4.27^{b}	0.13
Creatinine(mg/dl)	0.39^{c}	1.06^{a}	1.17^{a}	0.80^{b}	0.67^{b}	0.08
Glucose (mg/dl)	48.00^{b}	52.00^{b}	56.00^{b}	60.00^{a}	65.00^{a}	1.35
Triaglycerol (mg/dl)	41.20^{b}	40.16^{a}	36.87^{ab}	35.13^{ab}	35.13^{ab}	1.06
Cholesterol	91.70^{a}	89.83^{a}	83.77^{a}	60.50^{b}	60.50^{b}	4.21
AST (iu/L)	14.20^{b}	14.77^{b}	15.12^{b}	16.67^{b}	16.67^{b}	0.87
ALT(iu/L)	71.30^{a}	70.00^{a}	66.30^{b}	47.97^{c}	47.97^{c}	3.05

abcd Means in the same column with different superscripts were significantly ($p<0.05$) different. T1(0% replacement level), T2 (25% replacement level), T3 (50%replacement level), T4 (75% replacement level), T5 (100% replacement level).

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ASN 52nd Annual Conference Proceedings

Utilization of Exogenous Enzymes in Boosting Fibre Degradation in Poultry Nutrition – A Review

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Abstract
The review assessed the utilization of exogenous enzymes in boosting fibre degradation in poultry nutrition. Specifically, it explained the concept of enzymes, concept of dietary fibre, limitations of enzymes. A thorough literature approach and search was used for this study. The concept of exogenous enzymes indicates that enzymes help fundamentally to improve the efficiency of meat and egg production by changing nutritional profile of feed ingredient. Examples of enzymes includes but not limited to; Amylolytic Enzymes, β- glucanase, Xylanase, β-mannanase. For the purpose of this study, β-mannanase was the main focus due to the importance of the enzyme in poultry livestock. Previous empirical findings revealed that β-mannanase increases; feed conversion ratio, average daily gain, egg weight, overall egg production and also mitigates ileal viscosity in broilers fed at 2.5% guar hulls. One of the limitations linked with β-mannanase is, it does not ease the heat stress of aged laying hens raised under hot climatic conditions. The review concluded that the use of exogenous enzymes (β-mannanase) is important in poultry nutrition because it aids further physiological and morphological development as well as productivity of poultry animal. It was recommended that β-mannanase supplementation should be considered when low energy diets are formulated and under commercial conditions, birds require a minimum and a maximum amount of fiber in their diet for optimal performance.

Keywords: Exogenous enzymes, β-mannanase, Dietary fibre, Egg Production, and Poultry Nutrition.

Introduction
According to Amerah *et al*, (2015) feed are primarily produced to optimize the growth potential of the target animal through a defined nutritional specification. However, feed need to satisfy other criteria including feed safety, which is becoming an important priority and physical quality. Enzymes are organic catalyst that lowers the activation energy in a biological system thereby speeding the rate of reaction. Feed enzyme helps fundamentally to improve the efficiency of meat and egg production by changing the nutritional profile of the feed ingredient. Breanna *et al*, (2017) recently opined that feed constitutes the largest cost in commercial livestock production systems. As the cost of formulated rations increases, improving feed efficiency is an important step for farmers to have an economically sustainable business. Dietary fiber is a concept that is difficult to define chemically and is therefore not easy to measure in feed, Mateos *et al*, (2012). Establishing a proper definition for dietary fibre has historically been a balance between nutritional significance and the availability of adequate analytical methods, with a clear tendency to adapt the definition to the existing analytical procedures rather than to the physiological effects of the different fiber fractions on the physiology and health of the gastrointestinal tract. However, De Vries (2004) defined dietary fibre as the non-digestible fraction of plant cell walls in food and feed ingredients and typically includes oligosaccharides, pectic polysaccharides,

hemicellulose, cellulose, lignin, gums, and some minor associated plant cell wall substances. It encompasses very diverse polymers with large differences in physicochemical properties that, when included in the diet, result in differences in digestive viscosity, ion exchange capacity, fermentation capability, and bulking effect within the gastrointestinal tract. The effects of dietary fibre on voluntary feed intake, organ size, gastrointestinal tract motility, enzyme production, microbiota growth, and bird behaviour differs depending on the source of fiber. Specifically, the effects of dietary fibre on poultry physiology and productivity depend on the inclusion level and source of fiber as well as on the nature of the basal diet, the physical structure of the fiber source, the feed form, and the type and age of the birds, Mateos et al , (2012). In the last fifty years, feeding enzymes to poultry is one of the major nutritional advances. It is the culmination of something that nutritionists realized for a long time. Enzymes are one of the many types of protein in biological systems, Khattak *et al*, (2006). Their essential characteristic is to catalyze the rate of a reaction but is not themselves altered by it. They are involved in all anabolic and catabolic pathways of digestion and metabolism. Enzymes tend to be very specific catalysts that act on one or group of compounds known as substrates. Feed enzymes help break down anti-nutritional factors (e.g. fibre, phytate) that are present in many feed ingredients. Anti-nutritional factors can interfere with normal digestion, resulting in reduced meat or egg production and lower feed efficiency, and can also trigger digestive upsets. Feed enzymes are used to increase the availability of starch, protein, amino acids and minerals such as phosphorus and calcium from feed ingredients, Barlette, (2010). The largest cost of livestock production system is feed. As cost of formulated rations increases, improving feed efficiency is an important step for farmers to have an economically sustainable business. The objectives of this review are as follows; to explain the concept of enzymes, concept of dietary fibre and identify the limitations of enzymes. The paper review adopted a literature review approach in discussing utilization of exogenous enzymes in boosting fibre degradation in poultry nutrition.

Concept of Enzymes

The concept of enzymes in animal nutrition emanates century ago. Breanna *et al*, (2017) identified the enzymes supplemented to animal diets as follows; Amylolytic Enzymes, Proteolytic Enzymes, β- glucanase, Xylanase, β-mannanase and defined these enzymes as enzymes that are expected to increase the digestion and further utilize dietary starch, protein, β-glucose, arabinoxylans and β-mannan respectively. This review using poultry livestock as case study will focus more on the nutritional benefits and drawbacks of β- mannanase and β-mannan.

β – Mannanase (Beta-Mannanase)

From the American Biosystems, Beta-Mannanase (endo-1, 4-ß-mannanase) is made from a refined strain of Trichoderma reesei through liquid fermentation and extraction technology. Beta-Mannanase is a subcategory of hemi-cellulase, which can break the beta-1, 4 glycosidic bonds of mannan into mannan-oligosaccharides. The substrates are ß-mannan, galactomannan, and galactose. It improves the utilization of protein, fat, and carbohydrate by degrading plant cell wall structures.

Benefits of Exogenous Enzymes (β- Mannanase) in Poultry Livestock

In discussing the properties of β-mannanase this review considers the uses and benefits. According to Breanna, (2017) β-mannanase supplementation has proven to be highly effective in increasing feed conversion ratio, average daily gain, and carcass weight of poultry Additionally, increases in egg weight and overall egg production has been linked to β-mannanase supplementation in poultry. Lee *et al*, (2003) found that supplementation of β-mannanase not only removed growth depression and increased feed conversion efficiency, but also mitigated ileal viscosity in broilers fed a ration containing at least 2.5% guar hulls. Mok *et al*, (2013) further revealed that it increased ileal digestibility of amino acids such as leucine and phenylalanine. β-mannanase appears to reduce viscosity in the ileum and thus create an environment that promotes nutrient digestibility and gastrointestinal health. Besides production related improvement, health benefits of supplementing β-mannanase have been reported more often in non-ruminant species. From the findings of Cho and Kim, (2013) it was revealed that broilers fed β- mannanase have low density lipoprotein cholesterol. This indicates that there will be potential increase in dietary fat digestibility and availability of polyunsaturated fatty acids.

Practical Uses of Dietary Fibre

Under practical feeding conditions, gizzard function is enhanced when structural components such as whole grain, coarse particles, or fiber sources are included in the diet. According to Svihus, (2011), when moderate amounts of coarse fiber sources are fed, fiber accumulates in the gizzard and slow feed passage rate in the proximal part of the gastro intestinal tract. In respect of this, insoluble fiber sources such as oats hull or sun flower hull seem to play a more profound role on gizzard activity than soluble fiber sources such as sugar beet pulp. Fiber particles are in general, harder to grind than other dietary particles and consequently, tend to accumulate in the gizzard Hetland *et al*, (2005) where they stimulate organ development and function, especially when large insoluble, lignified fiber sources are used. Large, well developed gizzards, improves gastro intestinal tract motility, favours gastro duodenal refluxes, and stimulates the secretion of pancreatic enzymes Svihus *et al*, (2004). Under practical feeding conditions, particle size and solubility of the fiber fraction in the digestive environment and the degree of lignification are key characteristics affecting bird productivity because of their effects on rate of feed passage in the upper part of the gastrointestinal tract and fermentative ability in the distal part Saki *et al,* (2011). The effects of fiber inclusion on poultry performance depend on the physico-chemical characteristics of the fiber source as well as the species considered and the age of the bird. Probably, the response to fiber inclusion is more limited in pullets than in broilers and in fact, the effects of fiber on gastro intestinal tract development might disappear with time, once the pullets or the young hens are fed a regular laying diet. The effects of inclusion of dietary fibre on physiology and development of gastro intestinal tract, passage rate, microbial growth, nutrient digestibility and growth performance differ depending on the composition of the basal diet, feed form, type and level of dietary fibre and age of the bird, Jimenez *et al,* (2014). Under commercial conditions, birds require a minimum and a maximum amount of fiber in the diet for optimal performance. Therefore, diets for broilers should be formulated with a minimum and a maximum level of dietary fibre De Vries, (2004).

Effect of Dietary Fiber (β-Mannan Polysaccharide) in Exogenous Enzymes (β-mannanase)

According to Moreira and Filho, (2008), the polysaccharide β-mannan is a major component of the plant cell walls and can be classified into 4 groups: pure mannan, glucomannan, galactomannan, and galacto-glucomannan. The livestock industry continues to integrate plant by-products as feed to reduce feed costs. By-products commonly used in livestock diets that contain relatively greater amounts of β-mannans include palm kernel meal (32%), soybean hulls (8%), and soybean meal (3%) Breanna *et al*, (2017). β-mannans are typically known for their structures resistance to solubility that creates high viscosity in feed and therefore promotes anti-nutritive properties in animal feed specifically in poultry livestock Zaib *et al*, (2012). The viscosity of β-mannan has been proposed to be the reason for depressed digestion and absorption in the gut as well as decreased pancreatic enzyme activity within the small intestine of non-ruminants, Breanna *et al*, (2017). Additionally, β-mannans can greatly affect gastrointestinal health by initiating innate immune signalling receptors Ausubel, (2005) and by over-stimulation of immune functions of the mucosal walls in the intestine Zaib *et al*, (2012). Due to immune signalling and stimulation, β-mannan is associated with decreased nutrient utilization, thus requiring surplus nutrient intake to reach the production potential. Additionally, several studies link β-mannan to reduced gastric emptying.

Limitations of Exogenous Enzymes

According to the report by Moon *et al* (2017), the increase of β-mannanase to poultry livestock feeds has little positive impacts on performance and egg quality. Dietary β-mannanase did not ease the heat stress of aged laying hens raised under hot climatic conditions. Svihus *et al,* (2004) revealed that an excess of fiber may have opposite effects. The level of fiber required for optimal performance depends on the source of fiber considered, the age and health of the bird, and the trait studied. **(Make more research to make fleshy)**

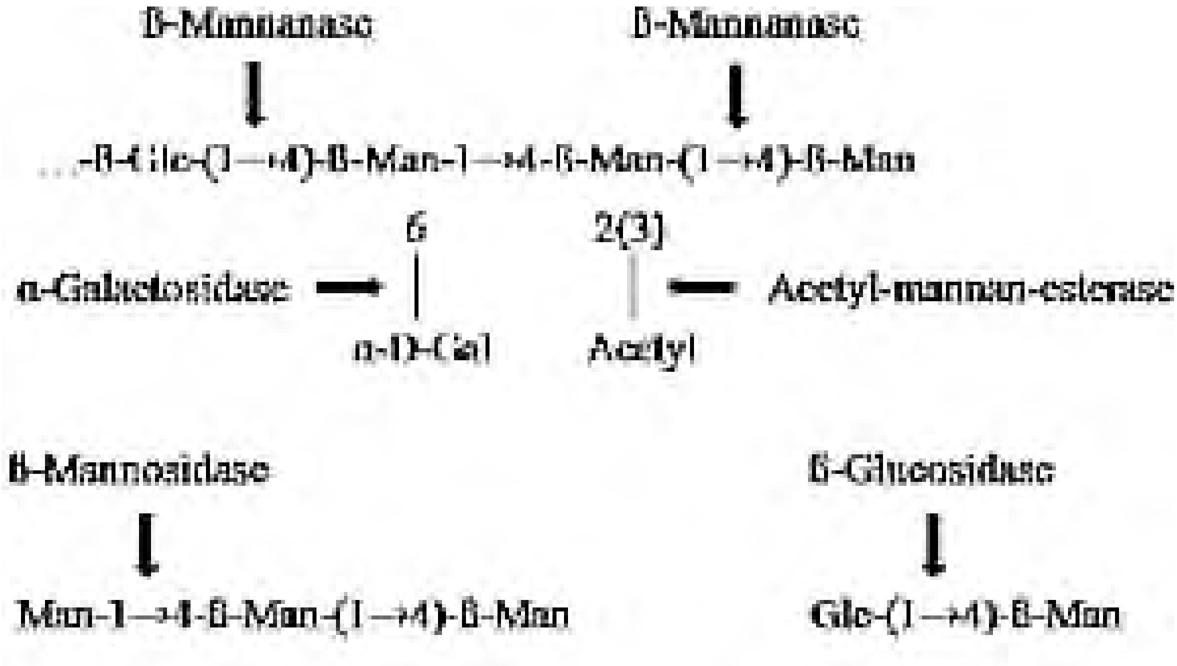

Figure 1: Structures of Enzymes and Polysaccharides
Source: Shastak *et al* , 2015
The structure shows the composition of β-mannanase in poultry nutrition

Conclusion

The review concluded that the use of exogenous enzymes (β-mannanase) aids physiological and morphological development as well as productivity of poultry animal. However, β-mannans promotes anti-nutritive properties in animal feed specifically in poultry livestock. The review recommended that β-mannanase and β-mannans should be added to poultry livestock feeds to aid productivity but the quantity of β-mannans added should be determined by the health and age of the bird so as to attain optimal performance.

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ASN 52nd Annual Conference Proceedings

Performance and economic evaluation of broiler fed jackfruit leaf meal as replacement for commercial vitamin – mineral premix.

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Abstract
This study was carried out to evaluate the performance and economic evaluation of broiler chicken fed jackfruit leaf meal as replacement for commercial vitamin-mineral premix. One hundred and twenty birds were randomly selected and allocated to four dietary treatments. In each of the treatment the jackfruit meal was used at different level of inclusion 0.00, 0.25, 0.50, 0.75 % respectively to replace commercial premix. The chicken was fed for seven (7) weeks i.e 49 days. Feed intake was measured daily, and the birds were weighed once weekly. Feed and water were given ad-libitum. The experimental design used is Complete Randomized Design (CRD). Result showed that there was significant difference ($P<0.05$) in feed intake among broilers fed 0% (T_1), 0.25% (T_2), 0.50% (T_3) and 0.75% (T_4) levels of inclusion of jackfruit leaf meal as a replacement for vitamin mineral premix. There was no significant difference ($P>0.05$) observed in daily weight gain among T_1 (12.811±1.93), T_2 (12.417± 0.376), T_3 (12.623 ± 0.597) and T_4 (12.176 ± 1.027). The result showed no significant in the feed cost benefit analysis.

Introduction
Poultry has been identified as a means of bridging the protein intake deficiency in Nigeria. The main limitation of expansion of poultry industry is the availability of adequate supplies of needed feed ingredient at reasonable price (Ani and Okone, 2005; Babatunde and Hazat, 2005).
Feed make up for about 70% of all the cost of production (Ademola and Farinu, 2006) and high cost of feed in mainly as result of competition of most ingredient between man and livestock for grain and conventional source of plant and animal protein(Adegbola, 2007; Emenalom, 2004).The most promising way to solve the problem of competition between man animal for protein is to identify cheaper and easier available feedstuff that are of low human preference and little or no industrial uses that can meet nutritional requirement of poultry with or without processing (Fanimo *et al*; 2004, Fasina *et al*; 2004) as reported by Onunkwo, 2017.
Jackfruit leaf is therefore found to be rich in vitamin and mineral, thiamin and riboflavin which helps in turning the food into energy and keep the eyes, hair healthy; It contains compound that have antimicrobial effect which could help prevent contamination with bacterial that causes food borne illness (Smriti, 2017).

Materials and methods
This study was carried out at the Teaching and Research Poultry unit of the Department of Animal Science and Technology, Faculty of Agriculture, Nnamdi Azikiwe University, Awka,

Anambra State. The location lies between Latitude 6.24^{0}N and 6.28^{0}N and longitude 7.00^{0}E and 7.08^{0}E on the South Eastern part of Nigeria, the climate is the tropical wet and dry type with a clear season, the mean daily maximum temperature is usually 27^{0}C all over the year although it could reach 34^{0}C in March and lowest during the harmattan months of December and January (Ezenwaji *et al,* 2013).
Jackfruit leaf meal was purchased at Ifite, Awka in Anambra State, Nigeria. Some branches were cut from the tree and later was manually plucked and sun dried for three (3) days, then crushed into fine particles size.
One hundred and twenty (120) day old chicks was randomly assigned into four (4) treatment group of 30 birds per treatment and 3 replicates of 10 birds per replicate. Complete Randomized Design was used. Each group was raised on wood shavings litter and contained with feeders and drinkers to provide *ad-libitum* access to feed and water. Chicks were brooded with charcoal stove and kerosene lamp for seven days, thereafter the intensity of light was reduced gradually from 14-16 hours/day. Routine vaccination against common diseases (Newcastle and gumboro) and medication was administered to birds and this was done throughout the experiment. The experiment lasted for seven (7) weeks. Three (3) weeks for starter phase and four (4) weeks for finisher phase.
The birds were fed with commercial feed at the first week, then the chicks were divided into four treatment dietary treatment groups as T_1 (0% JFLM), T_2 (0.25% JFLM), T_3 (0.50% JFLM) and T_4 (0.75% JFLM) as presented in Table 1 and 2 for starter and finisher diet.
Data were collected on initial weight, feed intake, average weight gain and feed conversion ratio. The cost of treatment diet (naira/kg) was recorded to determine the cost of each diet. Feed intake per bird per treatment for the experimental period was used to multiply the cost per kilogram feed to obtain the cost of feed consumed per bird. The cost per weight gain was determined which involves taking the pr5oduct cost per kg feed and feed to gain ratio (FGR) of consuming the diet.
All the data were subjected to Analysis of Variance as described using SPSS package (2003) windows version 8.0. and means separated using Duncan New Multiple Range Test (Duncan, 1955)

Table 1: Gross Composition of Experimental Diet for Broiler at Starter Phase

Ingredient	Diet 1	Diet 2	Diet 3	Diet 4
Maize	46.07	46.07	45.82	45.57
Wheal Offal	15.36	15.36	15.36	15.36
Jackfruit leaf meal	-	0.25	0.50	0.75
Soybean meal	27.26	27.26	27.26	27.26
Fish meal	6.82	6.82	6.82	6.82
Bone meal	3.50	3.50	3.50	3.50
Vit/min	0.25	-	-	-
Salt	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Total	100	100	100	100
Crude protein	22.99	22.99	22.97	22.95
Crude fibre	4.26	4.26	4.26	4.25
Energy(ME/Kcal/kg)	2931.34	2931.34	2922.35	2913.37

Table 2: Gross Composition of Experimental Diet for Broiler at Finisher Phase

Ingredients	Diet 1	Diet 2	Diet 3	Diet 4
Maize	54.70	54.70	54.45	54.20
Wheat offal	13.67	13.67	13.67	13.67
Jackfruit leaf meal	-	0.25	0.50	0.75
Soya bean Meal	22.83	22.83	22.83	22.83
Fish meal	3.80	3.80	3.80	3.80
Bone meal	4.00	4.00	4.00	4.00
Vit/min	0.25	-	-	-
Salt	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Total	100	100	100	100
Crude protein	19.99	19.99	19.97	19.95
Crude fiber	3.97	3.97	3.97	3.96
Energy(ME/Kcal/kg)	30008.43	30008.43	2999.41	2990.38

Results and Discussion

The result of this study showed that there was significant ($P<0.05$) difference in average feed intake among treatment group as shown in Table 3. T_1 had the highest feed intake. This finding contradicts with Mahadevan and Pradeep, (2009) that observed that the inclusion of *Moringa Oleifera* leaf meal at 5% and 7.5% respectively enhanced better feed intake

The result of this study showed that there was no significant ($P>0.05$) difference in weight gain amongst treatments. This could be due to the relatively similar crude protein of the four diets. T_3 recorded the highest weight gain. This is probably because the minerals, vitamins as well as amino acids in the jackfruit have higher biological functions which acted as growth promoter's enhancers, antimicrobial agents and absorption enhances, antimicrobial agents and metabolic modifiers (Gill, 2009). The birds differ significantly ($p<0.05$) from other treatment groups. The study agreed with the findings of El-Husseiny, (2002) that using medicinal plants mixture improves digestibility of broiler birds.

The results of feed conversion ratio of this study showed that there was significant ($P<0.05$) difference amongst treatment, however, T_3(9.47 ± 0.19) had the best feed conversion ratio, whereas T_2 (10.31 ± 0.28) had the least conversion ratio, this could be due to the relatively higher crude fibre content of the T_3 diet compared with the T_2 diet. This agrees with the work of Iguro, (2014) that observed significant difference ($p<0.05$) in the growth parameters among the four treatment fed jackfruit leaf meal.

The results of feed cost benefit analysis of this study showed that there was significant ($P<0.05$) difference amongst treatment, however, T_2 has the least cost, whereas T_1 had the highest cost. This could be due to high cost of commercial vitamin premix in the T_1 diet. This is in agreement with some works that reported leaf meal supplementation in the diet of poultry as a means of reducing high cost of conventional protein sources and to improve profit margin (Onyimonyi *et al.,* 2009). There was no significant ($P>0.05$) difference in the gross profit margin amongst treatments, this could be due to relatively similar cost of production of the birds. T_3 showed the highest profit margin while T_1 was the least. This is in agreement with some works that states that Leaf meal supplementation has been included in the diet of poultry as a means of reducing high cost of conventional protein sources and to improve profit margin (Iheukwumere *et al.,* 2008).

The result of this study showed that there was significant ($P<0.05$) difference amongst treatment with respect to return on investment. T_2 recorded the highest value on the return on investment while T_1 recorded the least. The result of this study showed that there was significant ($P<0.05$) difference amongst treatment with respect to return on investment. T_3 recorded the highest feed cost benefit while T_4 records the least.

Conclusion And Recommendation

It can be concluded that jackfruit leaf meal can be used replace vitamin premix by 0.25%, 0.50% and 0.75% because there is no significant (P>0.05) difference on weight gain among them. Although the best level of inclusion of jackfruit leaf meal as a replacement for vitamin premix is 0.50% since the broilers achieved their highest feed intake, weight gain, highest profit and least cost of production.

In view of the high cost of conventional vitamin premix as a source of vitamins for livestock and poultry, I recommend that jackfruit leaf meal can be used as a replacement for commercial vitamin premix at 0.50% level in broiler diet. This will obviously give a better performance and minimal cost.

Table 3: Growth performance of broiler birds fed Jackfruit leaf meal as replacement for commercial vitamin mineral premix

Parameter	T_1	T_2	T_3	T_4
Average daily feed intake per bird(g)	1280.03±20.33^a	1267.68±4.059^a	1195.18± 52.79^{ab}	1215.25 ± 40.79^b
Total Feed Intake(g)	6272.167±99.63^a	6211.6±19.89 ^{a}	5856.40 ± 258.71^{ab}	6073.73 ± 199.90^b
FCR	10.15±1.63^a	10.21 ± 0.28^a	9.47 ± 0.19^a	10.01 ± 0.61^b
Daily weight gain	12.81±1.93^a	12.41±0.37^a	12.62±0.59^a	12.18±1.1^a

T_1: 0% inclusion, T_2: 0.25% inclusion, T_3: 0.50% inclusion, T_4: 75% inclusion

Table 4. Feed cost benefit analysis of broiler birds fed Jackfruit leaf meal as replacement for commercial vitamin mineral premix.

Parameter	T_1	T_2	T_3	T_4
Cost of total feed consumed	125600 ± 1995^a	88671 ±283^b	91150± 4016^c	101275 ± 15497^c
Cost of production	125830 ± 1995^a	88901± 283^b	91150± 4016^c	100138±3353^c
Gross profit	387925 ± 55898^a	366275 ± 14366^a	370683 ± 11161^a	361774± 23680^a
Profit	262095 ± 66700^a	277373 ± 14132^a	279532± 7438^a	261636± 20666^a
%Return on investment	208.43±45.3^c	311.98 ± 15.08^a	306.86 ± 7.39^{ab}	261 ± 13.49^b
Feed Cost Benefit	130884±28133^a	138513±7057^a	139591±3714^a	130654±10320^a

T_1: 0% inclusion, T_2: 0.25% inclusion, T_3: 0.50% inclusion, T_4: 75% inclusion

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Growth performance of *Archachatina marginata* fed diets containing poultry dropping meal.

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Abstract
This study was conducted to assess the growth performance of Archachatina marginata fed diets containing poultry dropping meal. 120 grower Archachatina marginata snail species were used for the experiment which lasted for 8 weeks. Four treatment diets were formulated with inclusion of various levels of poultry dropping meal. Diet 1 (T1) had 0%, Diet 2 (T2) had 10%, Diet 3 (T3) had 20% and Diet 4 (T4) had 30% inclusion of sundried poultry dropping meal. The snails with similar body weight were randomly allotted to four different dietary treatments and each treatment was replicated three times with 10 snails in each replicate. Proximate analysis of the sundried poultry dropping was done at the beginning of the experiment to assess the proximate composition of the poultry dropping meal. Data were obtained on weight, shell length, shell girth, shell aperture, feed intake, shell thickness, cost per feed intake and feed cost per weight gain and were analyzed using one way Analysis of Variance (ANOVA) and Duncan Post Hoc Test. The result of the experiment showed that there were no significant differences (P>0.05) in weight gain, average daily weight gain, shell length increment, shell girth increment, shell aperture increment, shell thickness increment, total feed intake and average daily feed intake. There were significant differences (P<0.05) in the feed conversion ratio, cost per feed intake and feed cost per weight. Diet 2 (10% poultry dropping meal inclusion) recorded least feed cost per weight gain and best feed conversion ratio and so is recommended to snail farmers for maximal growth at low cost of production.

Keyword: Archachatina marginata, poultry dropping meal, growth parameters

Introduction

One of the most serious nutritional problems in the developing countries of which Nigeria is not excluded is the shortage of protein from animal sources and this is because, most of us are yet to discover what nature has endowed us with (Chidulue,2015). Animal proteins are more biologically complete than vegetable protein because they contain a complete range of amino acids that are essential for maintenance of health (Hoffman *et al.*, 2014). According to Ajibefun (2000) as cited in Amumihe *et al.,* (2015); the average animal protein intake in Nigeria is low, calling for concerted effort towards alleviating these crises of protein shortage. Food and Agricultural Organization (FAO) recommended 35g of animal protein per person for normal growth and development but average Nigerians consume 8g of animal protein out of the recommended (Oayida *et al.,* 2007) which is not far from the fact that the contributions of the conventional sources of meat as protein are not enough and at the same time too costly to meet the required need of an average Nigerian. This crisis then, can be alleviated by looking into unconventional sources as suggested by (Ebenebe, 2000; Etchu *et al.,* 2008) referred to micro livestock production.

Micro livestock production refers to rearing of unconventional animals of which the production of snail is part of it. Snails have been known as a valuable source of animal protein in many countries in the world. Its meat compares favourably to other conventional sources of animal protein like beef, pork and poultry meat (Nyameasem and Borketeyla, 2014). Snail meat popularly known as Congo meat in many parts of Nigeria is known to contain high protein, low cholesterol, iron, calcium, magnesium, phosphorus, copper and zinc as well as vitamin A, vitamin B6,vitamin B12,vitamin K, folic acid, etc (Ukpong, 2009). It is also relatively cheaper when compared to conventional sources (Fagbuaro *et al.,* 2006).
However, to rear these snails in captivity requires adequate supply of feed (balanced ration) as it constitutes the major factor in livestock production, thereby making the availability of feed resources at low cost the key to the success or failure of livestock industry (Omole, 2012). Snails are herbivores and feed on many plant feed resources like pawpaw leaf, banana leaves and so on (Omole, 2012) but such vegetables and fruit peels alone cannot meet the nutrient requirement for fast growth and reproduction in snail (Ebenebe *et al*., 2014) and so production of commercial feed for snail at low cost is deemed necessary.

Fish meal as feed ingredient in the formulation of snail feed due to its high cost adds to making these commercial feeds costly. Poultry droppings on the other hand, is a waste protein source and has a high content of nitrogen, readily available in large quantity from the birds managed in battery cages and some in deep litter in the south eastern states of Nigeria. According to Durunna *et al.,* (2015); poultry droppings can be used at any level as feed ingredients in the production of African giant land snails. It will make good business tool for making profit and there is need to investigate the use of poultry dropping meal as feed material beyond 28 days. Therefore, this work is aimed at determining the growth performance of *Archachatina marginata* fed diets containing poultry dropping meal and the level at which poultry dropping meal can conveniently substitute fish meal in snail feed and also the cost effectiveness of the use of poultry dropping meal as feed material to reduce fishmeal inclusion.

Materials and Methods

This research was carried out at the Snail and Edible insect unit of the Teaching and Research section of the Department of Animal Science and Technology in Nnamdi Azikiwe University, Awka (6°11'N and 7°02'E) according to Ezezue *et al.,* (2017). The snails were reared in plastic bowls of 7.5cm height, 28cm diameter, 88 cm circumference and 7.5litres capacity, filled to one-third with treated soil The poultry droppings used for the experiment was purchased from Handmaids Girls Secondary School, poultry farm, Amansea, Awka South Local Government Area, Anambra State, sundried and milled with its proximate analysis done. 120 grower snails (*Acharchatina marginata*) with average weight range of 52.40g to 59.85g were procured from Ochanja market, Onitsha, Anambra State. The 120 snails were allotted randomly to four diets of 30 snails per treatment. Each treatment was further sub divided into three replicates groups of 10 snails each. During the experiment, four dietary treatments were formulated based on the level of inclusion of the poultry dropping meal to reduce the fishmeal portion of the diet. These treatments were designated as Treatment 1(T_1) (had 0% inclusion of the poultry dropping meal with 5% fishmeal and served as the control), Treatment 2 (T_2) (had 10% inclusion of the poultry dropping meal with 4% fishmeal), Treatment 3 (T_3) (had 20% inclusion of the poultry dropping meal with 3% fishmeal) and Treatment 4 (T_4) (had 30% inclusion of the poultry dropping meal with 2% fishmeal).The Experimental design was therefore a Completely Randomized Design (CRD), with four treatments and three replicates per treatment with the model $Yij= \mu+ Ti+ Eij$ where Yij is observation made on i^{th} treatment (growth indices of snails) arising as a result of μ (population mean),Ti(Treatment effect), Eij(Experimental error),i(Number of treatment) and j(Number of replicates).The gross composition of each of the experimental diets is presented in table 1.

Table 1: Gross composition of the Experimental Diet used for the Study.

Ingredients	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)
Maize	21.00	17.00	20.00	13.00
Cassava flour	14.75	13.75	10.75	11.75
wheat offal	14.00	14.00	10.00	10.00
Soya bean meal	25.00	21.00	18.00	18.00
Groundnut cake	15.00	15.00	13.00	10.00
fish meal	5.00	4.00	3.00	2.00
poultry dropping meal(PDM)	0.00	10.00	20	30
Bone meal	2.50	2.50	2.50	2.50
Limestone	2.00	2.00	2.00	2.00
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
TM/Vit premix	0.25	0.25	0.25	0.25
Total	100	100	100	100
Crude protein%	24.03	23.97	24.14	24.19
Energy Kcal	2670.57	2640.60	2686.43	2646.25

The diets were presented to the snails in the flat round plastic troughs inside their respective bowls. The snails were fed once a day for 8 weeks and water sprinkled daily. Data on feed intake was collected daily while data were collected weekly on the following; body weight(measured in g using SF400 sensitive weighing scale), shell length and shell girth(measured in cm using A30018 Vernier caliper) and shell aperture (measured in cm using thread and meter rule). Data on shell thickness was collected only at the beginning and end of the experiment. Feed conversion ratio was obtained by dividing the total quantity of feed consumed by the total weight gain. The feed cost (₦/g)was calculated by dividing the total cost of ingredients (plus transport cost) by the total gram of feed produced for each group. Cost of feed intake was calculated by multiplying feed cost by total feed intake. Feed cost per weight gain (cost of production per treatment) was realized by multiplying feed cost(₦/g) by Feed conversion ratio.
Data collected were analyzed using one way analysis of variance (ANOVA), using SPSS Computer Software Package (version22) at 0.05 significant level. The sample means were separated using a Post Hoc Test (Duncan Multiple Range Test).

Result and Discussion

The chemical composition of the experimental diets is presented in Table 2.The proximate composition of the anand poultry dropping meal used is presented in Table 3 while in Table 4 is the summary of the performance of experimental snails. The result showed that there were no significant differences (P>0.05) on the weight gain as all the snails gained similar weight among treatments. Poultry dropping meal(PDM) had no significant effect on the feed intake as all the treatments compared favourably.This shows that PDM was well accepted by the snails and this agreed with the report of Ademolu(2005) who fed snails with 20% poultry dropping meal inclusion and pawpaw leaf. There were significant differences (P<0.05) on the feed conversion ratio between treatments; Treatment 4 (T4) had the highest value of 2.29 while Treatment 2(T2) had the lowest value(1.43) which implies that Treatment 2 converted less feed to more meat and so the best feed converter. No significant differences (P>0.05) were also observed on the shell characteristics of the snails (shell thickness, shell aperture, shell length and shell girth) and this means that poultry dropping meal (PDM) used as a feed ingredient to reduce quantity of fishmeal in snail feed had no negative effect on the shell characteristics. This could be as a result of relatively same ash content in the feed as shell of snail is made of calcium which is present in the ash(Hamzat 2004; Omole *et al.,* 2008). Feed cost per gram decreased as inclusion of PDM increased. Treatment 1(T1) had ₦0.315 while Treatment 2,Treatment 3(T3) and Treatment 4 had ₦0.267, ₦0.222 and ₦0.177 respectively. The lowered feed cost in Treatment 2 to Treatment 4 was as a result of cheap sourcing of alternative feedstuff which agreed with Abel *et al.,* 2014 that stated that there is lowered feed cost when an alternative feed ingredient is used in place of conventional feedstuff. Cost per feed intake(₦/g) was significantly lower($p<0.05$) for snails on T4(₦5.69) than snails on T3(₦7.53), T2(₦8.54) and lastly T1which had high value of ₦9.16. Significant difference($p<0.05$) was noted in the feed cost per gram weight gain(cost of producion), it was observed that T4(₦7.22) was similar with T3(₦6.98) and T3 being closely related to T1(₦5.67) and least in T2 (₦4.51).This pattern of increase in cost of production was influenced by feed conversion ratio.The chemical compositon of the experimental diet and proximate compositon of the poultry droppings meal are shown in table 2 and 3.

Table 2: Chemical Composition of the Experimental Diets.

Nutrients	T1 (0%)	T2 (10%)	T3 (20%)	T4(30%)
Dry matter%	91.24	91.24	90.04	90.02
Moisture%	8.76	8.76	9.96	9.98
Ash%	11.85	12.15	12.85	14.17
Crude protein%	23.63	21.88	20.13	18.38
Ether extract%	4.20	3.85	3.02	3.50
Crude fiber%	7.45	8.05	9.50	10.75
Nitrogen free extract%	44.12	45.31	43.94	43.22
Gross Energy Kcal/kg	3257.88	3215.46	3124.82	3252.01

Table 3: Proximate Composition of the Poultry Dropping Meal (PDM)

Content	% Composition
Dry matter	83.40%
Moisture	**16.60%**
Ash	20.14%
Crude protein	18.30%
Ether extract	1.30%
Crude fiber	18.68%
Nitrogen free extract	24.98%
Metabolizable energy	2625.05Kcal/g

Table 4: Growth performance of *Archachatina marginata* fed diets containing poultry dropping meal.

Parameters	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)
Average initial weight	52.65	53.85	59.85	52.40
Average final weight	63.90	65.05	70.65	62.2
Total weight gain	11.25±0.64	11.20±0.14	10.80±0.85	9.8±0.85
Average daily weight gain/snail	0.23±0.13	0.23±0.00	0.22±0.02	0.20±0.02
Average daily feed intake/snail	0.35±0.10	0.26±0.11	0.39±0.16	0.34±0.20
Total feed intake	17.39±5.00	12.95±5.35	19.33±7.83	16.70±9.81
Feed conversion ratio	$1.80{\pm}0.28^{ab}$	$1.43{\pm}0.03^{b}$	$2.21{\pm}1.15^{a}$	$2.29{\pm}0.42^{a}$
Av. Initial shell length	7.14	6.62	7.40	6.98
Av. Final shell length	7.23	6.69	7.46	7.05
Shell length increment	0.09 ±0.06	0.07±0.04	0.06±0.03	0.07±0.03
Av. Initial shell girth	4.21	3.95	4.41	4.19
Av. Final shell girth	4.49	4.24	4.62	4.51
Shell girth increment	0.27±0.11	0.29±0.01	0.22±0.01	0.33±0.05
Av. Initial shell aperture	9.96	9.67	10.55	10.04
Av. Final shell aperture	11.38	10.69	11.89	11.34
Shell aperture increment	1.41±0.04	1.02±0.30	1.34±0.31	1.30±0.01
Av. Initial shell thickness	0.74	0.79	0.69	0.65
Av. Final shell thickness	1.54	1.79	1.68	1.59
Shell thickness increment	0.80±0.02	1.00±0.05	0.99±0.31	0.95±0.33
Feed cost(#/g)feed	0.315	0.267	0.222	0.177
Cost per feed intake (#/g)	$9.16{\pm}0.16^{a}$	$8.54{\pm}2.44^{a}$	$7.53{\pm}0.70^{ab}$	$5.69{\pm}0.70^{b}$
Feed cost per weight gain (#/g)snail	$5.67{\pm}0.88^{ab}$	$4.51{\pm}0.09^{b}$	$6.98{\pm}0.46^{a}$	$7.22{\pm}1.32^{a}$

Data represents mean ± standard deviation. Row Sharing different superscripts are significantly different (P<0.05)

Conclusion

The result of the research suggest that poultry dropping meal can be included in all the proportions (10%, 20%, 30%) as feed ingredient to reduce fish meal inclusion in snail feed for the production of *Archachatina marginata* snails. The utilization of this poultry waste (faecal material) reduced waste and pollution in the environment and most importantly reduced cost associated with usage of fishmeal in snail feed.

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Haematological and serum biochemical indices of broiler chickens fed Roselle seed meal (*Hibiscus sabdariffa L.*) as replacement for groundnut cake

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Abstract
This study was carried out to evaluate the haematological and blood biochemical parameters of broiler chickens fed graded levels of Roselle Seed Cake (RSC) diet as replacement for groundnut cake (GNC). Proximate Composition of the test diet and experimental diets were conducted to determine their nutrient contents. Four diets were formulated for the broiler starter and finisher phases respectively; The Diet 1 served as the control diet while diets 2, 3 and 4 contained 8%, 16% and 24% with Roselle seed cake (RSC) diets respectively as replacement for groundnut cake (GNC). A total of 120 day old Ross broiler chicks were randomly allotted to four dietary treatments with four replicates and each treatment consisted of 30 birds in a completely randomized design (CRD). Feed and water were provided for the birds ad libitum. The blood parameters measured are haemoglobin, packed cell volume, red blood cell, white blood cell, heteropils, lymphocytes, monocytes, eosinophils, basophils and band cell. The results from the parameters measured for blood quality showed no significant (P<0.05) differences for haemoglobin level, packed cell volume (PCV), white blood cell (WBC), across the treatments. But the red blood cell (RBC), heterophils and lymphocytes had a significant difference across the dietary treatments and this implies that Roselle seed cake (RSC) inclusions in the diets of the birds had a positive effect on the oxygen carrying capacity, immunity level and antibodies producing capacity of the birds. The blood biochemical parameters measured are total protein, albumin, cholesterol, creatinine, triglycerides, HDL and LDL. The parameters measured showed no significant (P<0.05) differences in total protein (TP), creatinine, high density level (HDL) and low density level (LDL) across dietary treatment while albumin and cholesterol had significant differences (p>0.05) across the dietary treatments. RSC can replace GNC at 16% dietary inclusion levels.

Introduction
The poultry industry in Nigeria, in the last decade, has been greatly affected by high cost of feed (ogbuewu *et al*, 2010). The provision of feed alone has been reported to account for 60 - 80% of the total cost in most livestock production in developing countries such as Nigeria (Igboeli, 2000) and this emphasize the interest to develop local feedstuffs.
Protein is a very important nutrient that is responsible for growth and its deficiency leads to growth depression. Proteins are used in the construction of body tissues such as muscles, nerves, cartilage, skin, feathers, beak, and so on. All animals require protein for growth, reproduction and production depending on the age, productivity of the animal and their environment (Olomu, 1995)

The conventional protein feedstuffs for poultry such as soya bean meal (SBM), groundnut cake (GNC) and fish meal (FM) are scarce and expensive because they are competed for by humans as food and other industrial uses. The development of alternative protein feedstuffs in animal diets will therefore continue to be a necessity in developing countries. In view of this, there is increased interest by Nigerian livestock farmers to harness unconventional feed ingredients such as Roselle seed meal.

Roselle (*Hibiscus sabdariffa L.*) belongs to the *malvaceae* family and forms a popular vegetable in Indonesia, India and many tropical regions (Tindal, 1986). It is now widely grown in the North Eastern and middle belt regions of Nigeria (Akanya *et al*., 1997) mainly for its calyxes used for the preparation of a local drink but the leaves are also used for soup and as pot herb (Adigun, 2003). The leaves are used as vegetable and the floral parts in the preparation of "Zobo", a local drink. The stem provides fibre and the seeds are eaten by scavenging poultry(Phillips, 1997). The seed of *Hibiscus sandariff* is said to have high protein value and it is on account of its protein content that it is well priced for human consumption. They also contain high amount of minerals such as calcium, magnesium and phosphorus. The seeds from Nigeria are reported to contain about 35.90% crude protein, 10.14% ether extract, 10.09% ash and 15-17% crude fibre (Dashak and Nwanegbo 2002).

The use of blood examination as a way of assessing the health status of animals plays a vital role in physiological, nutritional and pathological status of such animal (Muhammad *et al*, 2000).

Haematology has been defined as the study of blood and an important part of clinical pathology as well as diagnostic process (Lutz and Pryluski, 2008). Haematology includes not only the examination of the cellular and fluid portions of blood, but also includes a study of the tissues that form, store and circulate blood cells. However, the serum is the component that is neither a blood cell nor a clotting factor. It is the part of blood that is like water and that contains substances (called antibodies) that fight disease.

Serum includes all proteins not used in blood clotting and all the electrolytes, antibodies, antigens, hormones and any exogenous substances (Martin, 2007). The result of haematology and serum analysis is usually used to assess the health status of an animal.

Haematological and serum parameters have been observed as good indicators of the physiological status of animal and their changes are important in assessing the response of such animal to various physiological situations (Khan and Zafar, 2005). This study was carried out to determine the effects of Roselle seed cake meal on haematological and serum biochemical profile of broiler chickens.

Materials and methods

The experiment was carried out at the Poultry Unit of Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Umudike is located within Latitude 5º 28' North, longitude 7º 32' East and on an altitude of 122m above sea level. The area falls within the Tropical Rainforest zone. Annual rainfall averages 2177mm. The monthly ambient temperature ranges between 20^{o}C and 36^{o}C, and relative humidity between 50 and 59%, depending on season (NRCRI, 2017).

The experimental materials; maize, Roselle seeds, soya bean meal, etc were procured from a local market in umuahia, abia state. Samples of the Roselle seedcake and experimental diets were taken to the Animal Science Biochemical Laboratory of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria for proximate analysis using the methods described by A.O.A.C (2005). The analysis was done to obtain the nutrient composition (Dry matter, Ash, ether extract, crude protein, crude fibre and nitrogen free extract) of the experimental diet. The metabolizable energy was determined using the Janssen formula (Janssen, 1989).

Four diets isonitrogenous and isocaloric diets (23.62 %CP; 2959kcal/kg ME) and (19.28 %CP; 2961kcal/kg ME) were formulated for the broiler starter and finisher phases respectively as follows: Diet 1: 0% of Roselle seedcake in the diet (control), Diet 2: 8% level of Roselle seed cake in the diet, Diet 3: 16% level of Roselle seed cake in the diet and Diet4: 24% level of Roselle seed cake in the diet. Gross composition of the experimental diets are presented in Tables 1 and 2 respectively.

One hundred and twenty (120) day old Ross broiler chicks were purchased from a reputable farm in Ibadan and were used for the starter and finisher phases. The broiler chicks on arrival were counted and were given a common ration for one day and allowed to adapt to the environment. Their initial average weight was recorded and the chicks were randomly distributed into four treatment groups of 30 chicks each with four replicates of 15 chicks per pen in a Completely Randomized Design (CRD). Each group was assigned to the four experimental diets and they were all subjected to the same management practices all through the period of the experiment.

The birds were given lasota Intra ocular (I.O) vaccine on arrival and vitalyte was added to their water to reduce stress. They were given their first dose of gumboro at 7 days old, first dose of lasota at 14 days old while second dose of gumboro and second dose of lasota were administered at 21 days and 28 days old respectively. The birds were also treated against coccidiosis orally at 3weeks of age.

In the starter phase (0-4weeks) the birds were assigned to four dietary treatments where RSC was included at 0, 8, 16 and 24% respectively. The 0% represents the control group without Roselle seed cake in their diets while others are fed diets with inclusion of Roselle seed cake in their diet. They were fed starter feed. Feed and water were provided *ad libitum* throughout the study period. In the finisher phase (5-8weeks) birds from the starter phase were used. The birds were assigned to four dietary treatments as in the starter phase but their feed was changed to broiler finisher feed. Feed and water were provided *ad libitum.*

At the end of the experiment, 1.5 millilitres of blood were collected from the wing vein of each bird with disposable 2ml syringes and needle set. Three birds per replicate making a total of nine birds per treatment were randomly selected. Blood samples were collected into labelled bottles containing Ethylene Diamine Tetra acetic Acid (EDTA) and taken to the nutrition and biochemical laboratory for determination of haematological parameters. The samples were assayed for: Packed cell volume (PCV), haemoglobin content (hb), white blood cell (WBC), red blood cell (RBC) and differential blood count (heterophils, lymphocytes, monocytes, eosinophils, basophils and band cell).

The data obtained from the study were analyzed using One-way ANOVA. The General Linear Model procedure of Statistical Analysis System (SAS, 2002) was used and the mean was separated using Dunnet because the control diet was used to compare with other treatments (Dunnet, 1964).

Results and Discussion

According to the proximate composition of Roselle seed cake presented in table 3, the dry matter content was 95.15%, crude protein 32.45%, crude fiber 4.25%, ash 6.25%, ether extract 10.05% and nitrogen free extract content was 50.05%. Ether extract value of 10.05% was lower than the value of 15.4% reported by some authors. The metabolizable energy value of 3059.64kcal/kg agreed with the range of 2880-3500kcal/kg reported by various authors. The variations in values obtained and reported by various persons could be as a result of different sources of Roselle seed cake, differences in processing methods and storage conditions.

The values obtained for haemoglobin (11.56-12.37g/dl) for broiler chickens 0% (control) diet to 24% diet group fell within the normal range values (8.00-13.00g/dl) for domestic chickens as shown in Table 4. This signifies that the birds had good aerobic capacity and were not aneamic.

The packed cell volume values obtained amongst the treatments are not significantly different ($p<0.05$) except for T_2 (8%) which is higher with value 37.27% and show a significant difference from others.

The red blood cells values obtained from T_4 (24%) and T_2 (8%) diets agrees with the average values of RBC (2.5-4.5mm^3) while that of T_3 (16%) and T_1 (0%) are a bit higher. This implies that birds under T_3 and T_1 diets had higher oxygen carrying capacity but none of the birds had depressed bone marrow.

There is no significant difference ($p<0.5$) in the white blood cell (WBC) values amongst the dietary treatments. This showed that the birds WBC produced antibodies which protected the birds from infectious agents.

The Heterophils were not significantly different ($p<0.05$) within the dietary treatments except for T_3 (16%) diet which is higher and significantly different ($p >0.05$). This implies that birds under T_3 diets had higher immunity to infections and bacteria than birds in other dietary treatments since high level of heterophil prevents infections.
The lymphocyte values obtained from T_2 (8%), T_3 (16%) and T_4 (24%) diets; 51.43-53.16% showed significantly different ($p>0.05$) from that of T_1 (control) diet; 50.02. They all agree with the average value which is around 20-55% but birds under the control diet produced lesser antibodies than birds under 8%-24% dietary treatments.
The differential counts like Eosinophil, Monocytes, Basophils and Band cells were not significantly difference ($p<0.05$) from each other across the dietary treatments.
There were no significant difference ($p<0.05$) in the total protein as shown in Table 5. The values obtained from the dietary treatments (2.75-3.01g/dl) agrees with the average total protein value (2.5-5.5g/dl) and this shows that the birds growth and body were proper.
There was significant differences ($p>0.05$) in albumin and cholesterol values of the different dietary treatments. This indicates that Roselle seed cake had an effect on the protein, cholesterol level and health status of the birds.
The creatinine values obtained (0.44-0.52mg/dl) fell within the range values (0.20-0.5mg/dl) and **t**his signifies that roselle seed cake did not have any detrimental effect on the kidney function of the birds because feeds were properly utilized by the birds.
There was significant difference ($p>0.5$) in tryglyceride value between the different dietary treatments with 24% dietary treatment being the highest amongst others.
High density lipoprotein (HDL) and low density lipoprotein (LDL) is a combination of lipids and proteins. The higher the lipoprotein value, the better because it lowers the risk of coronary artery disease.

Conclusion

Based on the findings from the study, it was concluded that Roselle seed cake (RSC) as an alternative feedstuff can replace groundnut cake (GNC) at 16% dietary roselle seed cake inclusion levels and incorporated in the diet of broiler chickens. Inclusion of RSC in the diets of broiler chickens did not have adverse effect on the haematology. Feeding RSC to broiler chickens do not have any adverse effect on their blood biochemical indices.

Table 3: Proximate composition and energy value of Roselle seed cake

Parameters	
Composition	%
Crude protein	32.45
Crude fibre	4.25
Dry matter	95.15
Ash	6.25
Ether extract	10.05
Nitrogen free extract	50.05
Metabolizable energy (kcak/kg)	3059.64

Table 4: Haematological parameters on broiler chickens fed graded levels of Roselle seed cake as replacement for groundnut cake

Parameters	T1	T2	T3	T4
Hb (g/dl)	11.56^{b}	12.37^{a}	11.06^{c}	11.55^{b}
PCV (%)	35.40^{b}	37.27^{a}	33.57^{d}	35.02^{c}
RBC ($\times 10^{6}$/dl)	4.60^{a}	4.10^{b}	4.47^{a}	3.99^{b}
WBC($\times 10^{3}$/ml)	4.44^{a}	4.33^{a}	4.08^{b}	4.27^{ab}
Heterophils (%)	14.31^{c}	14.32^{c}	16.24^{a}	15.77^{b}
Lymphocytes(%)	50.02^{c}	53.16^{a}	51.43^{b}	53.04^{a}
Eosinophils (%)	0.00	0.00	0.00	0.00
Monocytes (%)	0.00	0.00	0.00	0.00
Basophil (%)	0.00	0.00	0.00	0.00
Band cell (%)	0.44^{a}	0.00^{b}	0.00^{b}	0.00^{b}

Letters within rows of each parameter indicate significant differences with respect to different items tested at $p<0.05$., Hb= Heamoglobin, PCV= packed cell volume, RBC= Red blood cell, WBC= white blood cell

Table 5: Blood biochemical parameters of broiler chickens fed graded levels of Roselle seed cake as replacement for groundnut cake

Parameters	T1	T2	T3	T4
Total Protein(g/dl)	3.01^{a}	2.90^{a}	2.99^{a}	2.75^{b}
Albumin (mg/dl)	42.31^{b}	35.31^{c}	43.31^{a}	31.31^{d}
Cholesterol(mg/dl)	111.21^{d}	113.53^{c}	115.62^{b}	116.12^{a}
Creatinine(mg/dl)	0.52 ^{a}	0.45^{b}	0.52^{a}	0.44^{b}
Triglycerides(g/dl)	70.64^{c}	71.51^{b}	71.42^{b}	73.44^{a}
HDL(mg/dl)	70.64^{c}	71.51	71.42^{b}	73.44^{a}
LDL (mg/dl)	33.55^{a}	33.27^{b}	32.3^{c}	32.347^{c}

Letters within rows of each parameter indicate significant differences with respect to different items tested at $p<0.05$., HDL= High density lipoprotein, LDL= Low density lipoprotein

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Performance and economic evaluation of broiler chickens fed raw, dehulled and boiled kidney bean (*Phaseolus vulgaris*) seed meal based diet

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Abstract
This study was conducted to evaluate the performance of broiler chicken fed raw, dehulled and boiled kidney bean seed meal on the feed intake, weight gain, feed conversion ratio and the cost implication of feeding these diets. The experiment lasted for seven weeks (excluding 1week of acclimatization). A total of One hundred and twenty (120) unsexed day old Abor acre chicks were used for the experiment. The birds were weighed and randomly distributed into four treatments using Complete Randomized Design (CRD) with 30 birds per treatment and 10 birds per replicate. The dietary treatments were replicated three times and they include T_1, T_2, T_3 and T_4 which were diets made without kidney bean, with raw kidney bean, dehulled kidney bean and boiled kidney bean respectively. The diets were fed at both starter and finisher stages. The feed intake was recorded daily while the weight gain was recorded weekly but the cost implication of feeding the diets to the birds was assessed at the end of the experiment. The data collected were subjected to analysis using SPSS and differences between means were separated using Duncan Multiple Range Test. Highest value of average daily feed intake was recorded in T_1(13.77) followed by T_4(13.63) and then T_3(13.21) while the lowest value was recorded in T_2(11.96). There was no significant difference ($p>0.05$) between birds fed T_1 and T_4 diets. There was no significant difference between birds fed T_3, T_4 and T_1 diets. There was no significant difference between birds fed T_3 and T_2 diets. There was a significant difference ($p<0.05$) between birds fed T_1 and T_2 diets as well as in birds fed T_4 and T_2 diets. There were no significant differences between the treatments ($p>0.05$) in the total weight gain of the birds. The Feed Conversion Ratio (FCR) of the different treatments were not significantly different ($p>0.05$). There was no significant difference ($p>0.05$) in the cost of feed per weight gain in T_2, T_3 and T_4 diets. It is concluded that aqueous heating is better for processing kidney beans for inclusion in the diets of broiler chickens as well as for a cheaper cost of production.

Introduction
Feed is one of the essentials in animal production. In animal feed, the protein required is supplied by both animal and plant sources of protein. The plant protein sources are cheaper compared to animal protein sources and the plant protein supplements are lower in some essential amino acids, energy and minerals such as phosphorus as compared to animal protein supplements (Yun *et al*., 2005). In recent times, there has been a wide gap between production and supply of animal protein to feed the ever increasing population of over 140 million Nigerians (National Population Commission, 2006) resulting in low per capita consumption of the product (Christopher *et al.* 1997 as cited by Oyebode, 2015). This high cost of broiler production leads to low poultry production, high cost of poultry meat and protein malnutrition in household. According to other researchers, the high cost of feed for poultry production is mainly based on the high cost of energy and protein sources of the feed. Kidney bean (*Phaseolus vulgaris)* is considered as a potential component of diets of pigs and poultry. Kidney bean contains high amounts of protein and energy, and amino acids content is similar to that of soybean except for a lower level of methionine (Laurena *et al*., 1991 as cited in Emiola, 2011). It is also a rich source of vitamin, minerals and relatively high in

crude fiber. The Seeds are also rich in calcium, phosphorus and iron. According to Audu *et al* (2011), the minerals contained in red kidney bean include the following: calcium, nickel, zinc, manganese, magnesium, copper, iron, cadmium, lead, sodium, potassium, phosphorus, chromium while the amino acids includes lysine, histidine, arginine, aspartic acid, threonine, serine, proline, glutamic acid, alanine, valine, cysteine, methionine, isoleucine, phenylalnine and tyrosine. The fresh pods and green leaves are used as vegetable. Kidney beans are also known as the chilli beans. These are dark red in colour and visually resemble the shape of a kidney (Soumya *et a1*, 2012). Kidney bean as well as other legumes has been reported to contain anti-nutritional factors particularly haemagglutinin and trypsin inhibitors (Amaefule *et al*., 2005; Teguia *et al*., 2008; Akande *et al*., 2010; Maidala *et al*., 2016) which limit their utilization in animal feeding. The objective of this study was to evaluate the growth performance, the FCR and the cost implication of feeding differently processed kidney bean seed meal based diet to broiler chickens.

Materials and methods

The study was carried out at the Poultry unit of Teaching and Research farm in the Department of Animal Science and Technology, Faculty of Agriculture, Nnamdi Azikiwe University, Awka, Anambra state. Awka town is located between latitude 6.24^{o}N and 6.28^{o}N and longitude of 7.00^{o}E and 7.06^{o}E on the South Eastern part of Nigeria, the climate is the tropical wet and dry type with a clear cycle of seasons. The mean daily maximum temperature is usually 27^{o}c all over the year although it could reach 34^{o}c in March and lowest during the harmattan months of December and January, the mean annual rainfall according to the local meteorological station which has maintained climatological records since 1978 reveal a mean rainfall of about 1600mm with a relative humidity of 80% at dawn. (Ezenwaji *et al.,* 2013).

The kidney beans used for this experiment were measured, sorted, weighed and subjected to the different processing methods. For boiled, the dry seeds were sorted, weighed and then poured into a cooking pot with water boiling at 100°c and heated for one hour after which it was spread under the sun using an empty rice bag until they were sufficiently dried. For the Dehulled, the dry seeds were soaked in cold water for between 18-24 hours then the outer seed coat removed using a grinding machine then the hand was used to separate the seed coats from the bean. The beans were then rinsed and sundried using empty rice bag until they were sufficiently dried. The raw kidney bean together with the dehullled and boiled kidney beans were then ground and used in formulating the broiler diets.

The birds were fed with four compounded experimental starter and finisher diets having crude protein content of 22% and metabolizable energy of 3000kcal/g and 20% crude protein and metabolizable energy of 3000kcal/kg respectively. The Percent composition of differently processed kidney bean meal based diet fed starter and finisher broiler chickens is shown in table 1 and table 2. Proximate analysis was carried out on the starter and finisher diets and the results are presented is table 3 and table 4.

A total of one hundred and twenty day old unsexed broiler chicks (Abor acre 308 strain) were used for this experiment. The birds were acclimatized for one week. The birds during this period were fed commercial feed (vital feed). From the second week, the birds were randomly weighed and allocated to four treatment diets using a Completely Randomized Design (CRD) with thirty (30) birds per treatment and ten (10) birds per replicate. The birds were also assigned to four treatment diets namely: T_1, T_2, T_3, and T_4. The treatments were T_1- control, T_2- birds fed raw kidney bean seed meal, T_3- birds fed de-hulled kidney bean seed meal, T_4- birds fed boiled kidney bean meal. The birds were brooded for four weeks on deep litter using kerosene lanterns and charcoal stove. The birds were offered feed and water *ad libitum*. Vaccination and other management practices were maintained. The data collected were subjected to Analysis of variance (ANOVA) using SPSS analytical package and differences between means were separated using Duncan Multiple Range test (Duncan 1955).

Table1: Percent composition of differently processed kidney bean meal based diet fed starter broiler chickens

Ingredients	(T1) Control	T2 (Raw kidney bean)	T3 (Dehulled kidney bean)	T4 (Boiled kidney bean)
Maize	50.5	47.0	47.0	47.0
Wheat offal	4.0	4.0	4.0	4.0
Soya Bean Meal	21.0	21.0	21.0	21.0
Kidney Bean Meal	_	10.0	10.0	10.0
Groundnut cake	10.0	5.75	6.0	5.75
Palm kernel cake	6.75	4.0	3.75	4.0
Fish meal	3.5	4.0	4.0	4.0
Bone meal	3.0	3.0	3.0	3.0
Methionine	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10
Vitamin premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total (kg)	100	100	100	100
Calculated composition (%)				
Crude protein	22.02	21.90	21.94	21.90
Metabolizable energy (kcal/g)	2979.70	2949.07	2948.63	2949.07
Crude fiber	4.3	4.36	4.34	4.36

Table 2: Percent composition of differently processed kidney bean meal based diet fed finisher broiler chickens

Ingredients	T1 (Control)	T2 (Raw)	T3 (Dehulled)	T4 (Boiled)
Maize	52.0	49.0	49.0	49.0
Wheat offal	12.0	6.2	6.2	6.2
Soya bean meal	19.0	18.0	18.0	18.0
Kidney bean meal	_	10	10	10
Groundnut cake	6.2	6.0	6.0	6.0
Palm kernel cake	3.0	3.0	3.0	3.0
Fish meal	3.0	3.0	3.0	3.0
Bone meal	4.0	4.0	4.0	4.0
Methionine	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10
Vitamin premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total (kg)	100	100	100	100
Calculated composition (%)				
Crude protein	19.98	20.23	20.23	20.23
ME(Kcal/g)	2935.10	2976.48	2976.48	2976.48
Crude fiber	4.67	4.58	4.58	4.58

Table 3: Proximate analysis of differently processed kidney bean meal based diet fed starter broiler chickens

Parameters per sample	T1	T2	T3	T4	Boiled kidney bean sample	Dehulled kidney bean sample	Raw kidney bean sample
Dry matter (%)	91.18	90.71	90.81	91.61	90.01	86.53	91.31
Moisture (%)	8.82	9.29	9.19	8.39	9.99	13.47	8.69
Ash (%)	6.39	6.99	7.29	7.49	3.40	3.14	3.78
Crude protein(%)	16.59	15.75	17.45	19.21	19.21	21.00	20.98
Ether extract (%)	3.20	4.35	4.22	4.10	1.85	1.80	1.60
Crude fiber (%)	4.90	7.15	6.95	6.10	7.20	3.80	6.50
Nitrogen free extract (%)	60.10	56.47	54.90	54.71	58.35	56.79	58.45
ME k/cal/g	3479.05	3493.21	3496.35	3528.35	3515.56	3252.01	3553.54

ME means metabolizable energy

Table 4: Proximate analysis of differently processed kidney bean meal based diet fed finisher broiler chickens

Parameters Per Sample	T1	T2	T3	T4
Dry matter (%)	89.22	89.12	89.07	89.36
Moisture (%)	10.78	10.88	10.93	10.64
Ash (%)	8.84	8.19	8.29	8.54
Crude protein (%)	18.38	18.38	19.25	20.13
Ether extract (%)	3.45	4.50	4.35	4.18
Crude fiber (%)	6.35	4.75	5.70	6.00
Nitrogen free extract (%)	52.20	53.30	51.48	50.51
ME k/cal/g	3203.33	3266.30	3265.46	3268.58

Results and Discussion

The result of the growth performance of broiler chicken fed differently processed kidney bean is presented in table 5. There was significant ($p<0.05$) difference in average feed intake among the treatment diets. The boiling of dietary kidney beans probably rendered their diets more palatable than other processing methods studied. The low feed intake of the chicks fed the raw kidney bean diet could be due to the presence of anti-nutritional factors, which lowered the palatability of the feed. This finding agrees with the work of Akanji *et al* (2015), who reported that feed intake was similar ($P>0.05$) between birds fed control diet and dehulled – cooked cowpea diet, but significantly ($P<0.05$) reduced in those fed raw cowpea, dehulled cowpea and dehulled – roasted cowpea respectively. It also agreed with Wafar *et al*(2016) and Damang *et al* (2017) as they reported difference among the birds fed raw diet and other diets. There was no significant ($p>0.05$) difference in the total weight gain of the birds fed the different diets. This report agrees with that of Fikru *et al*(2014) which he reported that there was no significant ($p>0.05$) differences in initial and final body weight among the treatments. This work disagreed with Wafar *et al* (2016) who reported that the result of average daily weight gain was significantly ($P<0.05$) different and it ranged from 31.46g/bird in T_1 fed diet to 35.80g/bird in T_2 diet.

There was no significant difference ($p>0.05$) in the FCR of the different treatments. This report agrees with the report of Fikru *et al* (2014) which he stated that the feed conversion efficiency did not differ ($p>0.05$) among treatments and that of Taburuwa *et al.* (2016) who reported that there was no significant difference ($P>0.05$) in feed conversion ratio of the birds fed seed meal of African locust bean (*Parkia biglobosa*). Feed cost per weight gain recorded the highest value in T_2 (77.53) followed by T_3 (74.04) and then T_4 (69.44) while T_1 recorded the lowest value with 50.84. The feed cost per weight gain in $T_1$was significantly different from other dietary treatment ($p<0.05$). There was no significant difference ($p>0.05$) in the cost of feed per weight gain in T_2, T_3 and T_4. The diets containing kidney bean were not significantly different and this could be said to be due to the cost of the kidney bean in the diet. These variations in the numeric values of the cost of feed per kg weight gain may be due to differences in the processing costs of the kidney beans, and variations in the efficiencies of feed utilization across dietary treatments.

Table 5: Growth of differently processed kidney bean.

	Dietary treatments			
Parameters	T1	T2	T3	T4
Initial live Wt.(g/bird)	92.07	85.43	87.60	86.60
Final live Wt.(g/bird)	2524.30	1549.80	1845.77	1942.70
Total Wt. gain(g)	2432.36±1280.15	1464.61±106.92	1758.12±149.34	1856.12±59.51
Avg. daily Wt. gain(g)	49.64±26.13	29.89±2.18	35.88±3.05	37.88±1.21
Avg. daily FI(g)	13.77±0.92^{a}	11.96±0.44^{b}	13.21±1.02^{ab}	13.63±0.32^{a}
Total FI(g)	674.58±45.12^{a}	586.28±21.54^{b}	647.32±49.77^{ab}	667.97±15.54^{a}
FCR	0.32±0.12	0.40±0.03	0.37±0.00	0.36±0.00
Feed cost/ Wt. gain(₦/kg)	50.84±18.44^{b}	77.53±6.12^{a}	74.04±0.99^{a}	69.44±1.05^{a}

Mean having different superscripts are significantly different at $p<0.05$, Wt. = weight, FI=Feed Intake, FCR=Feed Conversion Ratio, g = gram, Avg. = average, T1= treatment1 (control), T2= treatment2 (raw), T3=treatment3 (dehulled), T4=treatment 4(boiled).

Conclusion

The study concluded that boiling of kidney bean gives best result in growth performance; therefore, processing kidney beans for broiler chickens diet improves growth and it is cheaper to use boiling for processing kidney beans for inclusion in the diets of broiler chickens as it showed a lower value for feed cost per weight gain.

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Response of broiler birds reared under aluminium sulphate treated litter

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Abstract
This study was conducted to investigate the efficacy of litter amendment on broiler performance. A total number of 120 day old Ross 308 broiler chicks were randomly assigned to two equal groups. One bearing the control group and the other group was kept on deep litter treated with Aluminium sulphate [$Al_2(SO_4)_3$]. Each having 30 chicken in four replication of 15 chicken in a Complete Randomized Design (CRD). The treatment groups were T_1 control (0g of alum), T_2 (300g of alum per 4.86sqm), T_3 (400g of alum per 4.86sqm) and T4 (500g of alum per 4.86sqm). The experiment lasted for 9 weeks. Data on final body weight, average daily weight gain, average daily feed intake, total feed intake, feed conversion ratio and protein efficiency ratio were collected. At the beginning and end of the experiment the litter samples were collected and the ammonia and nitrogen gas level were determined. The data obtained from this experiment were analysed using one way Analysis of Variance (ANOVA) and Duncan Multiple Range Test. The findings of this study showed that there were significant ($P<0.05$) differences in final body weight, T4 recorded the highest in finial body weight (3.70±0.01), and in total weight gain (2.86±0.01) while T_1 (control) recorded the lowest in finial body weight (2.88±0.01), and in total weight gain (2.03±0.01). There was no significant ($P>0.05$) differences in average daily weight gain, total feed intake, average daily feed intake, feed conversion ratio, and protein efficiency ratio for all the treatment. There were significant ($P<0.05$) difference in the level of ammonia at the starter phase, T_4 had the highest. (9.52±0.00) and T_3 had the lowest (5.97±0.43) and there was no significant ($P>0.05$) difference in the level of nitrogen gas emission in all the treatment. At finisher phase, there was no significant ($P>0.05$) difference in the level of ammonia and nitrogen gas emission in all the treatment. From the results obtained it is safe and best to use 500g of alum per 4.86sqm for improved growth performance and good litter quality making sure that the level of ammonia is not up to 25ppm.

Key words: Aluminium sulphate, litter quality, broiler birds, growth performance

Introduction
The world's population is expected to reach more than 9 billion by 2050, imposing food security challenges particularly for developing countries (Yadav *et al.,* 2016). Moreover, economic growth has increased the demand for livestock products putting pressure on the livestock sector to produce more with limited resources. Nevertheless, the livestock sector is one of the fastest growing agricultural sectors, contributing about 40 percent of the global value of agriculture production (Yadav *et al.,* 2016) supporting the livelihood and food security of almost 1.3 billion people. In intensive commercial broiler production, birds are reared on floor having absorbent material which is of different types to keep the floor reasonably dry to ensure comfortable condition for birds. It also gives the birds a suitable medium on which feeding, watering and other management practices are carried out. As poultry production increases, the amount of litter required by the system also increased. Broilers spend most of their lives in contact with their litter. The rapid growth of the poultry industry has increasingly raised concern of disposal (Musa *et al*., 2012). In Nigeria, about 932.5metric tonnes of commercial poultry manure were reported to be

produced (Musa *et al*., 2012). The current record of annual poultry manure appears to be unknown but is expected to be multiples of the above figures. Consequently both litter management and disposal raise important challenges to the poultry industry. Source of litter materials usually varies according to region (Gilaneh *et al*., 2016). Sawdust, wood shaving, rice or oat hulls, sugar cane pulp or bagasse, chopped straw, paper mill by product, corn cobs and dried leaves are often used as litter sources (Gilaneh *et al.*, 2016). Litter is composed of the bedding material plus the excreta, feed, feathers and water. Poultry litter that is a mixture of bedding material and manure has high organic matter and macronutrient and micronutrient contents, leading to the formation and release of ammonia as volatile compounds (Chung *et al.*, 2015). Following defecation by birds, the breakdown of faecal matter in litter occurs leading to the production of various gaseous pollutant whose concentration and emission is influenced by the litter type, management, humidity and temperature (Arjumand *et al.,* 2017). In addition, poultry litter provides an ideal environment for microbial proliferation. It also helps the thermal insulation, moisture absorption and reduction of ammonia emissions and serves as protective barrier from the ground (Gilaneh *et al*., 2016). Litter quality may be the origin of environmental and management problem in commercial poultry industry (Gilaneh *et al*., 2016) if not properly selected or managed. In broilers production, poor growth performance, compromised immune system and increased incidence of breast burns and blisters, leg abnormalities and foot pad dermatitis have been reported in literature as partially due to poor litter condition (Gilaneh *et al*., 2016). In broilers production, poor litter management results to poor growth performance which compromised immune system and increased incidence of breast burns and blisters, leg abnormalities and foot pad dermatitis and also production and emission of harmful gas like ammonia have been reported in literatures as partially due to poor litter condition (Gilaneh *et al.,* 2016) Therefore, treatment of poultry litter materials will reduce incidence of poor health condition and improve performance of birds leading to increase in the earnings of poultry farmers.

Materials and methods

The study was carried out at the Poultry Unit of the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. Nsukka lies in the derived savannah region and is located on longitude 6’25’N and latitude 7’24’E and at altitude of 430m above sea level. It has the natural day length of 13 to 14 hours; mean maximum weekly indoor and outdoor temperature of 27.9 $^{\circ}$C to of 27.9 $^{\circ}$C and 26.8 $^{\circ}$C to 30.5 $^{\circ}$C, respectively, mean maximum weekly indoor and outdoor temperature; 20.5°C to 22.3°C and 20.0 $^{\circ}$C to 23.60 $^{\circ}$C, respectively, relative humidity of 73.1% to 76.6% and mean total monthly rainfall of 781.33mm (Energy centre UNN, 2008). The study lasted for 9 weeks and was conducted in two phases (Starter and finisher).

Aluminium sulphate ($Al_2(SO_4)_3.14H_2O$ or alum was purchased in powdered form procured at Head bridge, Onitsha. It reduces ammonia volatilization and its offensive odour. The floor of each pen in the experimental unit was covered with bedding material (dry wood shaving) and alum was mixed into top ½ inch by broadcasting method. During the application of alum to the litter, protective covers like goggle, gloves, nose mask and boots were worn to prevent inhalation of the alum dust and skin irritation.

120 day old Ross 308 breed of broiler chicks were used for the study. The wood shaving was obtained from timber market in Nsukka. The treatment groups were T_1 control (0g of alum), T_2 (300g of alum per 4.86sqm), T_3 (400g of alum per 4.86sqm) and T4 (500g of alum per 4.86sqm). The chicks were vaccinated on the first day and brooded together for 4 weeks due to the cold weather that was experienced during the time of the study. The brooding was carried out using charcoal pot as heat source. Fresh water and feed were given to the chickens *ad libitum*. Drinkers were washed on daily basis with clean water and clean sponge. The chickens were given a routine vaccination. Chicks from 0-4weeks were fed with starter mash containing 22% crude protein and 3000kcalME/kg. From 5-9weeks, the chickens were fed with finisher mash of 19% crude protein and 3100 kcalME/kg. A commercial feed named “Hybrid feed” was used. Proper sanitation and bio-security measures were carried out like, washing the pens and brooding house with Izal and clean water, then fumigation using formalin before the arrival of the chicks, making sure that the water mixed with Izal in the foot dip at the doors of brooding house and experimental units were changed daily The following parameters were measured; Weekly body weight, Daily feed intake, Daily protein intake and Protein efficiency ratio. Litter samples were collected at week 5 and 9 at 5

random locations from each pens. The litter samples collected inside a plastic bag weighed 1kg and it was thoroughly mixed with droppings. The litter sample was subjected to laboratory tests using boric acid trap system/method and sulphuric acid calorimetric method. Chemical analysis was done on the litter sample to analyse ammonia (NH_3) and nitrogen gas (N_2). In determining the nitrogen level, 0.5g of poultry litter sample were weighed in a 500cm^{3}Kjeldahl flask, 1g of catalyst mixture and 20cm^3 of conc.H_2S0_4.added and digest it on the kjeldahl digestion heater until all the traces of carbon changed to white fumes. When cooled, 50cm^3 of distilled water was added and the substance was washed in another flask of 100cm^3 volume with distilled water up to 100ml volume leaving the poultry litter. 10cm^3 of the poultry litter was added and digested in 10cm of 45% NaOH then connect it immediately on kjeldahl distillation assemble, after the receiving flask (100cm^3) must have contained 20cm^3 of 2.5% boric acid with 2 drops of the mix indicator was also fixed. The electricity heater for distillation was put on to collect about 50cm^3 of the distillate. The distillate 0.05N HCL was titrated from blue distillate to pinkish end point and the titre was used to determine the nitrogen gas content in the poultry litter sample.
In determining the ammonium, 2g of the poultry litter was weighed into a 250ml shaking bottle. 100ml of distilled water was added and shook in a mechanical shaker for 30minutes. It was allowed to settle and filtered with a watman 110cm tilter paper, then the filtrate was used to determine ammonia. 50ml of the extract was pippete into a 250ml conical flask and 20ml of 20% formalin solution added and mixed thoroughly. 3 drops of phenolphthalein indicator was added and the suspension titrated with 0.1N Sodium hydroxide solution to a permanent pinkish colour end point. Then the titre value was used to calculate the ammonia content in the poultry litter sample using the formula below:

$$T \times \text{Normality} \times \text{Equivalent weight} \times \frac{1000}{\text{Weight used}}$$

NB: all in mg/kg as unit of reporting result.
The data collected were subjected to analysis of variance (ANOVA) in a Complete Randomized Design (CRD) using a Static Graphic Computer Package (SPSS, 2007) Model. Means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

Results And Discussion

The performance of broiler birds reared under litter materials treated with aluminium sulphate is shown in table 1. The mean final body weight and total body weight gain were significantly ($P<0.05$) different among the treatment group. There was no significant ($P>0.05$) difference in mean average daily weight gain among the four treatment group. The differences observed in the final body weight and total body weight gain of the four treatment groups could be attributed to the differences in aluminium sulphate inclusion levels on the litter where various groups were reared. This is suggested in as much as other genetic and environmental factors such as breed, light, temperature, humidity, age and other management practices were the same in each of the treatment groups. The total body weight gain results obtained in T_4 (500g of alum per 4.86sqm) are somewhat consistent with those of Moore *et al.,* (2000) which reported that alum treatment to poultry litter resulted in increase in weight gain.
However, there was no significant ($P>0.05$) difference in average feed intake among treatment group. T_1 consumed the highest feed, followed by T_2, T_3 and T_4 respectively. Feed intake decreased progressively with age of the birds in all groups. This showed that the birds consumed less feed as they grew older. The level of nitrogen gas and ammonia affects the feed intake of birds (Moore *et al.,* 2000). The energy level of ration plays important role because birds generally consume more to satisfy their energy requirement (Hill and Dansky, 1954).
There was no significant ($P>0.05$) difference in the feed conversion ratio among the treatment groups. T_4 had the best feed conversion ratio followed by T_3, T_2 and T_1. It progressively decreased with the age of the birds in the four treatment groups. The findings from this study corroborate with those of Moore *et al.,* (2000) which reported that alum treatment to poultry litter resulted in improved feed conversion ratio.
There was no significant ($P>0.05$) difference in the protein efficiency ratio among the treatment group. Protein efficiency was equally observed to have progressively increased with the age of the

birds in the four treatment groups. This shows that due to good feed conversion ratio the birds were able to attain high protein efficiency ratio.

Table 1: Growth performance of broiler birds reared under aluminium sulphate treated litter

Parameters	Treatment 1	Treatment 2	Treatment3	Treatment 4	P-value
Initial body weight (kg)	0.85±0.00	0.85±0.00	0.85±0.00	0.84±0.00	
Final body weight (kg)	2.88^{d}±0.01	3.08^{c}±0.00	3.17^{b}±0.00	3.70^{a}±0.00	0.00
Total body weight gain (kg)	2.03^{d}±0.01	2.23^{c}±0.00	2.32^{b}±0.01	2.86^{a}±0.01	0.00
Average daily weight gain (kg)	0.40±0.32	0.08±0.00	0.08±0.00	0.10±0.00	0.512
Average daily feed intake (kg)	0.15±0.00	0.15±0.00	0.14±0.00	0.13±0.00	
Total feed intake (kg)	63.38±0.00	61.97±0.00	57.90±0.00	55.52±0.00	
Feed conversion ratio (g)	2.14±0.00	1.87±0.00	1.66±0.00	1.29±0.00	
Protein efficiency ratio	2.66±0.00	2.99±0.00	3.395±0.00	4.29±0.00	

Means bearing different superscripts in the same rows are significantly different ($P<0.05$)

The nitrogen gas values obtained in the starter phase showed no significant ($P>0.05$) difference in the nitrogen gas level but T_3 had the highest (2.87±0.) while T_4 had the lowest (2.38±0.42) as shown in table 2. Ammonia level in T_1 and T_2 (6.92±1.21 and 7.48±0.56 respectively) are statistically similar with T_4 (5.97±0.43) and that of T_1 and T_2 (6.92±1.21 and 7.48±0.56) are statistically similar to T_3 (5.97±0.43) but T_3 (5.97±0.43) and T_4 (5.97±0.43) are significantly ($P<0.05$) different from each other.

At finisher phase both the nitrogen gas and ammonia level did not show any significant difference among the treatment groups as presented in table 3. T_2 had the highest (3.01±0.21) while T_3 had the lowest (2.38±0.00). In ammonia level, T_2 (5.795±0.61) had the highest while T_3 had the lowest (3.29±0.07). The results are somewhat consistent with those of Moore *et al.,* (2000) which reported that alum treatment to poultry litter resulted in decrease in ammonia level when there is decrease in nitrogen gas and increase in ammonia level when there is increase in nitrogen gas.

Table 2 Nitrogen gas and ammonia level in the aluminium sulphate treated litter in starter phase

Parameter	Treatment 1	Treatment 2	Treatment 3	Treatment 4	P-value
Ammonia (mg/kg)	$6.92±1.21^{ab}$	$7.48±0.56^{ab}$	$5.97±0.43^{b}$	$9.52±0.00^{a}$	0.088
Nitrogen gas (mg/kg)	2.80±0.28	2.87±0.07	2.87±0.21	2.38±0.42	0.585

Means bearing different superscripts in the same rows are significantly different ($P<0.05$)

Table 3 Nitrogen gas and ammonia level in the aluminium sulphate treated litter in finisher phase

Parameter	Treatment 1	Treatment 2	Treatment 3	Treatment 4	P-value
Ammonia	4.63±1.43	5.795±0.61	3.29±0.78	4.76±0.61	0.402
Nitrogen gas	2.73±0.21	3.01±0.21	2.38±0.00	2.59±0.35	0.383

Conclusion

The present study revealed that litter amendment with alum has an important role in augmenting broiler growth performance, feed conversion and efficient utilization of protein. Alum treated litter at 400g/4.86sqm was more efficient in controlling nitrogen gas and ammonia level of the litter than alum litter at 500g/4.86sqm but alum litter at 500g/4.86sqm had the best performance in respect to weight gain. But all the litter treatment had better performance than that of control group with respect to finial body, total body weight, protein efficiency ratio and litter quality. So the use of acidifier like alum in litter is beneficial to maintain the litter quality which directly enhances the productivity in broiler production without any adverse effect.

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Effect of Natural Clean probiotic on the carcass yield and organ characteristics of broiler birds

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Abstract
This study was conducted to investigate the effect of Natural clean probiotic on the carcass yield and organ weight of broiler chickens at the Poultry unit of Teaching and Research farm, Nnamdi Azikiwe University, Awka. A total of 96 Abor acre day old broiler chicks were randomly allotted to four treatment group in a Complete Randomized Design. Four levels of Natural clean probiotics were added in water as follows: T1(0g Natural clean probiotics), T2 (1.5g Natural clean probiotics), T3 (2.5g Natural clean probiotics) and T4 (3.5g Natural clean probiotics) which served as treatments for the experiment that lasted for 8 weeks. Commercial feed (Top feed) was used as the experimental diet. Each treatment had 3 replicate of 8 birds per treatment. Diet were fed in two phases, starter phase (from day 0-28days) and finisher (from day 29-56days). Carcass yield and organ weight measurements were obtained at the end of eight weeks. Statistical analysis was done using SPSS version 22. There were no significant (p>0.05) effect of the treatment on the carcass yield and relative organ weight. It was observed that T_2 had the highest dressing weight percentage (71.97%) which compared favourably with the control T_1(70.75%), T_3(69.82%), T_4 (67.85%). However the results are the same statistically, hence, the natural clean probiotics improved the carcass yield and organ weight. Therefore, natural clean Probiotics can be used in water to enhance broiler performance.
Keyword: Natural clean, Probiotics, Carcass yield, Organ weight, Broiler birds.

Introduction
The poultry farming is a means of bridging the protein deficiency gap common in many developing countries of the world (Jibir and Usman, 2003). It is an efficient means of supplying the fast growing human population with high quality protein (Gueye, 2004). The average Nigerian still consumes far less animal protein than his counterpart in the developed world because the animal production industry is still in its infancy due to hydra-headed problems and the low per capita income leading to a consumption of less than 9g of animal protein per capita per day as compared to over 50g per capita per day in North America and Europe (Grigg 1995; Boland *et al.* 2013). Broilers are important source of protein rich in essential amino acids that are required for the teeming population in terms of human growth. Also broiler has low level of cholesterol content which has also increase the demand of broilers in developing countries. However, poultry industries has always been confronted with challenges in form of various diseases such as bacteria caused diseases which includes fowl cholera, avian tuberculosis, *Escherichia coli* infections. These lead to increase use of antimicrobial growth promoters (AGP) especially antibiotics and growth hormone in order to combat these challenges and boost broiler production. Antibiotics are among the most widely used veterinary drugs in poultry industries (Simon and Baxter, 2006). Antibiotics has been used in poultry farming for several decades in combating bacterial infections (Olatoye and Ehinowo, 2009) as growth promoter (Geidam *et al*., 2009). Unfortunately, edible poultry tissues may be contaminated with harmful concentration of drug residues due to continuous and improper antibiotic usage in poultry industry (Shareef *et al*., 2009; Jarere,2015) Also the presence

of poultry diseases has reduced the production of broilers in poultry farming. As a matter of fact, the use of antibiotics in animal production has been banned in Europe since 2006. Furthermore, the use of sub therapeutic antibiotic dose in animal feeds or water to promote growth and improve feed efficiency was eliminated effectively January 1, 2017, as a new Food and Drug Administration (FDA) veterinary feed directive in the United States. Consequently, following the ban on the use of antibiotics and the urgent need to increase livestock productivity, there is then the need to find an alternative way to boost livestock production. Therefore probiotics is an alternative to antibiotics in order to increase livestock production. In other words probiotic are now replacing chemical growth promoters (Yirga, 2015). According to Food and Agriculture Organisation, FAO and World Health Organisation, Probiotics are live micro- organism which when administered in adequate amount confer a health benefit on the host (FAO, 2016). This definition was accepted and adopted by International Scientific Association for Probiotics and Prebiotics (Hill *et al.,* 2014). Many researchers have reported that probiotics have a beneficial effect on the broiler performance, modulation of micro flora and pathogen inhibition by lowering the gut pH, thereby improving sensory characteristics of dressed broiler meat. Therefore, this study was aimed at determining the effect of graded levels of Natural clean probiotics on carcass yield and organ weight of broiler chickens.

Material and Methods

The experiment was carried out at the Animal Science Teaching and Research Farm in Nnamdi Azikiwe University, Awka, Nigeria. The site is situated at 6.242889 degree North(N), 7.11829 degree East Ezenwaji, 2013). A total of 96 birds of the breed Abor acre were obtained from Fidan Chicky chicks located at Ibadan, Oyo state. 24 birds were allocated per treatment, each treatment were replicated thrice with 8 birds per replicate. The treatments involves the probiotics (Natural Clean) gotten from Lagos State Agriculture Development Authority (LASADA). Natural clean probiotic culture media comprised kelp, salt, milled corn, rice hull, calcium and hydroxide. Commercial feed (Top feed) were given *ad libitum* and the chemical composition is presented in table 1. The natural clean was given at 0g (T1), 1.5g (T2), 2.5g (T3), and 3.5g (T4) in clean drinking water for 56 days.

At 56 days, total of 12 birds were slaughtered. Prior, to slaughtering, the birds were starved of feed for 12 hours, hence live weight of the birds were taken. In the slaughtering process, modified kosher method was followed by cutting the birds jugular vein leaving the trachea and oesophagus attached to the body. After the slaughtering process the chicken was allowed to bleed for about 11/2 minutes before scalding. Scalding was done for about half minutes in an hot water which was not up to the boiling point for easy removal of feather, hence plucked weight was taken. Also eviscerated weight was taken after internal organs were removed. The shank and head were also removed in order to obtain the dressed weight.

The primal cut such as the breast, back, wings, drumstick, neck, shank were obtain from the dressed carcass. Hence, all were weighed using kitchen scale (7000g) capacity. Organ weight -Organ such as the liver, heart, spleen, proventiculus, lungs, gizzard, kidney, abdominal fat, pancreas, small and large intestine were separated and weighed.

All data were subjected to analysis of variance, and the means were separated using Duncan's Multiple Range Test (Duncan, 1955) as outlined by Daniel (1991).

Table 1: Chemical composition of the experimental diet

	Starter	Finisher
Crude protein	21.00	18.00
Fat and oil	6.00	6.00
Crude fibre	5.00	5.00
Calcium	1.00	1.00
Available phosphorus	0.45	0.40
Lysine	1.00	0.85
Methionine	0.50	0.35
Salt	0.30	0.30
Metabolisible energy kcal/kg	2900	2900
Net wet/kg	25	25

Results and Discussion

The result of the carcass yield of broiler birds offered natural clean probiotics at is shown in table 2. There was no significant difference (p>0.05) observed in the live weight, plucked weight, eviscerated weight, dressed weight of broiler chicken. These findings proved that natural clean probiotics can be used in raising of broiler chickens. However, It was observed that T_2 recorded the highest dressing weight percentage of 71.97% when compared to T1(70.75%), T3(69.82%), T4 (67.85%). This is in agreement with the report of Afsharmanesh and Sadaghi, (2014) that there is no difference in carcass yield, growth rate and feed efficiency of bird at day 42 with a treatment using commercial probiotics (galli-pro) containing *B. subtilis*. However this findings contradict the report of Addel-rahman *et al*. (2013) that the carcass yield of broiler at 42 days increased concurrently with increased growth rate and improved feed efficiency with the use of commercial probiotics (antra pro EF) *E. Faecium* in drinking water at the rate of 2g per 100 birds. Consequently, FAO (2016) reported that the effect of probiotics on carcass yield may be as a result of inconsistency in response due to difference in probiotics strain or breed of birds. Inconsistency may be due to different concentration and species of the direct fed microorganism. The mean organ weight of broiler birds offered natural clean probiotics is presented in table 3. There is no significant difference (P>0.05) on the relative organ weight. Hence, this findings is in line with the report of Zhang *et al. (*2012) that relative organ weight were unaffected by dietary inclusion of probiotics containing *Bacillus subtilis.*

The weight of proventiculus for T_1, T_2, T_3 and T_4 are the same statistically, there was no significant difference (p>0.05). among the treatment group. T_1 had the highest weight (13.67g) and T_3 had the lowest (11.00g). Similarly, T_1 which is the control group had the highest liver weight as (48.00g) compare to T_2(41.31 g), T_3(38.67 g),T_4 (37.67 g). There was no significance (p>0.05) difference in spleen weight which is in agreement with Awad *et al.* (2009) who reported no significant difference in weight of liver, spleen and caecum in broiler birds offered probiotics. The highest empty gizzard value (42.33g) was obtained in T_4 followed by T_1(41.33g), T_2(35.67g) and T_3(34.00g). Following the same trend, abdominal fat had no significance(p>0.05) difference among the treatment. This was in concurrence with the result of Franciszek *et al.,* (2010) who reported that probiotics bacteria (*Pseudoccocus specie*) have no effect on the weight of gizzard, liver, abdominal fat.

Table 2: Carcass yield of broiler chickens offered natural clean probiotics

Parameter	T1	T2	T3	T4		
Carcass		**Mean**			**SEM**	**P-value**
Live weight	2579.33[a]	2551.33[a]	2594.00[a]	2631.00[a]	65.70	0.99
Plucked weight	2453.67[a]	2405.67[a]	2415.00[a]	2305.33[a]	65.27	0.91
Eviscerated weight	2010.33[a]	2064.33[a]	2091.67[a]	1965.00[a]	52.99	0.88
Dressed weight	1821.00[a]	1818.00[a]	1810.33[a]	1785.67[a]	49.44	0.99
Dressing weight %	70.75[a]	71.97[a]	69.81[a]	67. 84[a]	3.60	0.62
Prime cuts %						
Breast	37.47	38.58	40.67	39.67	0.72	0.49
Back	14.71	13.79	12.84	13.43	0.39	0.44
Drumstick	15.74	15.08	17.46	16.38	0.40	0.17
Thigh	14.13	14.18	14.41	14.08	0.32	0.99
Wings	11.92	10.77	11.74	10.92	0.22	0.13
Neck	6.68	6.98	7.32	6.74	0.19	0.71
Head	4.14	4.49	4.02	4.41	0.11	0.45
Shank	6.19	5.96	6.61	7.28	0.30	0.49

[a] *within the row, means with the same superscript are not significantly different (p > 0.05)*

Table 3: Effect of probiotics on the relative organ weight of broiler birds offered natural clean probiotics

Relative organ Weight (g)	T1	T2	T3	T4	SEM	P-value
Liver	48.00	41.33	38.67	37.67	2.15	0.36
Heart	14.33	12.33	12.67	10.67	0.62	0.23
Spleen	3.33	2.67	3.33	2.67	0.33	0.84
Proventiculus	13.67	12.00	11.00	12.00	0.52	0.37
Lungs	11.67	13.33	16.33	15.00	0.95	0.37
Gizzard	63.67	57.67	56.00	64.33	2. 89	0.72
Empty gizzard	41.33	35.57	34.00	42.23	1.58	0.28
Kidney	30.67	23.67	24.00	33.33	1.55	0.74
Abdominal fat	32.67	38.67	31.33	24.67	2.28	0.70
Pancreas	25.00	22.33	25.67	29.33	0.98	0.28
Large intestine	31.00	34.00	37.00	29.33	1.47	0.63
Small intestine	88.67	94.00	79.33	73.33	5.61	0.15

Means within the row, means with the same subscript are not significantly different (p > 0.05)

Conclusion

The findings from this study revealed that the carcass yield and organ weight were not negatively affected by the inclusion of the natural clean probiotics, hence there were no significant difference on the parameters measured . therefore, concluded that the probiotics (natural clean) resulted in an enhanced carcass yield and organ weight.

Recommendations

Based on the study, it can be recommended that:

- Probiotics (Natural clean) can be used in water up to 1.5g for effective carcass yield and organ weight.
- Probiotics can be used as an alternative for antibiotic growth promoters as pressure to eliminate antibiotics in animal production increases.
- Probiotics Natural Clean offer good alternative to improve poultry production.

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Performance and economic evaluation of *Archatina fulica* fed varying inclusion level of whole Jackfruit meal

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Abstract
An experiment was conducted to investigate the performance and economic evaluation of Archatina fulica fed varying inclusion level of whole Jackfruit meal (WJM). A total of 120 growing Archatina fulica snails were allocated to four treatments (T_1, T_2, T_3 and T_4) replicated three times with ten snails per replicate in a Complete Randomized Design. The snails in T_1, T_2, T_3 and T_4 were fed 0%, 5%, 10% and 15% inclusion levels of the whole jackfruit meal based diets. The experiment lasted for eight weeks. The parameters measured include the weight gain, feed intake, feed conversion ratio, shell length, shell aperture, shell girth and shell thickness increase. The data obtained were analyzed using one way analysis of variance (ANOVA). The proximate analysis result of the test ingredient (Whole Jackfruit meal) showed that WJM had a crude protein content of 11.34%, crude fibre of 5.85%, and ash content of 4.75%. The result of the experiment showed that there was no significant ($P>0.05$) difference in the shell length, shell aperture and shell thickness amongst the treatment but snails fed T_2, T_3 and T_4 recorded higher values than control. There was significant ($P<0.05$) difference in the shell girth increment with T_4 having the highest value. There was no significant ($P>0.05$) difference in feed intake, weight gain and feed conversion ratio of snails across the treatments. Snails fed the T_4 diet had the least cost of production but did not maximize growth; however T_3 (10%) though it had a higher cost of production than T_2 and T_4 and lesser cost of production compared to T_1 (control) was not statistically different but numerically greater in maximizing growth than T_1, T_2 and T_4, thus is recommended to snail farmers.

Key words: Archatina fulica snails, whole jackfruit meal, Performance, Economic evaluation.

Introduction
Food which is a combination of macro and micro nutrient is a basic necessity of life. Food must contain all the necessary nutrients to make it balanced. Nutritious food are those food items that contain the required macro and micro nutrient in a normal proportion, including fruits and vegetables, which contain nutrients such as vitamins, protein, carbohydrates and minerals that are required to sustain the body and provide healthy living (Olhorst *et al.,* 2013). Eating food without the right nutrient composition could lead to malnutrition. It has been estimated that the daily minimum crude protein requirement of an adult in Nigeria varies between 65 and 85g per person. However, it is recommended that 35g of this minimum requirement should be obtained from animal products (Adetunji and Adepogu, 2011). The conventional and regular sources of animal protein in the country like beef, pork, goat meat, fish, and poultry are getting out of the reach of the common populace due to their high price as a result of the economic downturn in recent years (Akinnusi, 2004). Emphasis is presently on the micro-livestock to either complement the conventional sources of animal protein supply or as a major alternative animal protein source. A rich source of animal protein that had being under-utilized for years in West Africa and is highly prolific is snail. There is great need to make snail meat available all seasons of the year, it has therefore become necessary to initiate some organized form of domesticating/ rearing snails. This

calls for effort towards feeding snails with cheap locally available but rich feed ingredients, to minimize the effect of high cost of compounded feeds and seasonality of plant materials to ensure the continuity of snail production all year round.

Hence, there is need to search for locally available and cheap sources of feed ingredients particularly those that do not attract competition with human. This has led to the consideration of whole Jackfruit (*Artocarpus heterophyllus*) meal as feedstuffs for snails. Jack fruit can be considered as the largest fruits amongst edible fruits; it has multiple fruit (syncarp) with a green to yellow brown rind (Jahan *et al*. 2011). Several research works have been carried out on the seed meal of jack fruit on livestock but not much has being carried out on the whole jack fruit on livestock, therefore the utilization of whole jackfruit as functional feed ingredient included in snail feed seems an interesting beneficial research which merits a study.

Materials and Methods

The study was carried out at the Snailery unit of Teaching and Research farms of the Department of Animal Science and Technology, Faculty of Agriculture, Nnamdi Azikiwe University, Awka, Anambra state. The location lies between Latitude 6.24^{0}N and 6.28^{0}N and longitude 7.00^{0}E and 7.08^{0}E on the South Eastern part of Nigeria, the climate is the tropical wet and dry type with a clear season, the mean daily maximum temperature is usually 27^{0}C all over the year although it could reach 34^{0}C in March and lowest during the harmattan months of December and January (Ezenwaji *et al,* 2013).

A total of one hundred and twenty *Archatina fulica* were procured from a reliable source and transported to the study area in a well aerated polyethylene bags. The snails were fed with vegetables for the one week acclimatization period. After acclimatization, the snails were randomly assigned into different bowls according to the levels of whole jackfruit meal inclusion that is T_1, T_2, T_3 and T_4. T_1 which served as control did not contain whole jackfruit meal while T_1, T_3 and T_4 contained 5%, 10% and 15% whole jackfruit meal respectively. Each of the treatment was replicated three times in Completely Randomized Experimental Design. Ten (10) snails were randomly placed into the twelve bowls which had the dimension 15cm depth and a diameter of 56cm in a circular pattern which was filled with sterilized garden humus soil obtained from forested areas around the experimental site at the depth of 3cm and which was subsequently watered. A flat plastic container was used as feed saucer and contained their feed which was placed at the middle of the bowl. The bowl was then covered with mosquito netting material and tied with a twine to avoid intrusion of insects.

The snails were fed once a day, in the evenings due to the snail's nocturnal feeding habit. They were served with a feed saucer which was cleaned on daily basis. The snails in treatment one (T_1) were fed with diet without any inclusion of whole jackfruit meal, those in T_2 had 5% level of inclusion of WJM, T_3 had 10% level of inclusion of WJM and T_4 had 15% level inclusion of WJM as presented in table 1. The feed saucer was cleaned daily before introduction of fresh feed.

The feed intake was measured by subtracting the feed refused from feed offered on daily basis. The shell length and shell girth were measured using Vernier caliper on weekly basis. The shell thickness was measured using a micrometer screw guage at the beginning and end of the experiment. The shell aperture circumference was measured using a thread and meter rule on weekly basis. The weight gain was measured using a sensitive scale on weekly basis.

The proximate analysis to chemically evaluate the nutritional potential of the WJM and experimental diets was determined by the methods of AOAC (2002) as shown in table 1 and 2 respectively

Results and Discussion

The proximate analysis of the experimental diet is shown in table 1. Crude protein of 19.63 (T_1), 19.42 (T_2), 19.31 (T_3) and 18.94(T_4) showed that there was minimal decrease in crude protein content as the percentage inclusion of whole jackfruit increased. Crude fibre, dry matter content and metabolizable energy of the diets increased minimally as the percent inclusion of whole jackfruit meal increased. The ether extract, nitrogen free extract and ash content varied without a specific pattern. The moisture content reduced minimally as the percent inclusion of whole jackfruit meal increased. The minimal difference between the experimental diets showed that it was homogenous.

The proximate analysis carried out on whole jackfruit meal whole jackfruit meal contains a crude protein of 11.34% and metabolizable energy of 3619kcal/g which compares favourably with that of maize and sorghum, this shows that whole jackfruit meal could serve as a functional feed ingredient.

The shell growth characteristics of *Archatina fulica* fed different inclusion levels of whole jackfruit meal (WJM) is presented in table 3. There were non-significant (P>0.05) difference amongst the four treatments on the shell length, shell aperture and shell thickness increase, these showed that the T_2, T_3, and T_4, compared favourably with the control diet in terms of shell length, aperture and thickness. The result also showed significant (P<0.05) difference in the shell girth increase, with T_4 having the highest value and T_3 and T_1 having the least value, this showed that at T_4 shell girth increase is optimum

The growth performance of *Archatina fulica* fed different levels of whole jackfruit meal (wjm) is shown in table 4. There were non-significant (P>0.05) difference in the average daily feed intake, total feed intake, total weight gain, average daily weight gain and feed conversion ratio. This shows that the inclusion of whole jackfruit have no negative effect on the body growth performance of *Archatina fulica.* However, T_4 recorded a numerically lower feed intake and weight gain when compared to other treatments and T_3 had a numerically higher feed intake and weight gain, compared to other treatment and T_2 had the best feed conversion ratio, the lowered feed intake and weight gain observed in T4could be attributed to the antinutritional factors present in whole jackfruit meal. Akande *et al.,* (2010) also stated that anti-nutrients, also known as anti-nutritive compounds or physiologically active compounds or anti-nutritional factors, are substances that may produce undesirable effects when they are consumed by an animal.

The feed cost benefit analysis is presented in table 5. The cost of feed per gram of diet was least in T_4 and highest in T_1, The lowered cost of feed in T_2 to T_4 was as a result of cheap (free) sourcing of the alternative feed stuff. Abel *et al.,* (2014) also reported that there is reduced feed cost when an alternative feed ingredient is used in place of conventional feedstuffs. The cost of feed intake was highest in T_1 and least in T_4. The feed cost per weight gain which is also the cost of production was highest in T_4 and least in T_2.

Conclusion and Recommendation

The study showed that whole jackfruit meal can be used as a functional feed ingredient as it has a crude protein, energy, and fibre content that is comparable to maize and sorghum. Whole Jackfruit meal improved the shell growth characteristics (shell length, aperture, thickness and shell girth) of *Archatina fulica*. The body weight characteristics showed that whole jackfruit meal included at 10% improved weight gain and feed intake, whereas feed conversion ratio was improved at 5% inclusion. Inclusion of whole jackfruit meal reduced the cost of feed at 15% but the cost of feed per weight gain was reduced at 5%.

The findings of this result shows that it is safe to recommend that *Archatina fulica* could be fed whole jackfruit meal to help improve their shell growth characteristics, whole jackfruit powder meal should be included between the levels of 5-10% inclusion levels to achieve maximum feed intake, weight and feed conversion ratio. Although 15% inclusion saved more money for feed production, it wasn't efficient in maximizing growth. Therefore to save cost of feed production and also maximize growth of *Archatina fulica* 10% inclusion of whole Jackfruit meal should be used for feeding *Archatina fulica*

Table 1: Chemical Composition of the Experimental Diets

Nutrients	T_1 (0%)	T_2 (5%)	T_3 (10%)	T_4 (15%)
Crude protein %	19.63	19.42	19.31	18.94
Crude fiber %	4.20	4.44	4.56	4.75
Ether extract %	1.15	1.30	1.18	1.85
Ash%	11.8	12.0	11.7	13.17
Moisture%	9.58	9.57	8.99	8.78
Nitrogen free Extracts%	53.56	53.21	54.17	52.51
Dry Matter%	90.42	90.43	91.01	91.22
Metabolizable energy kcal/g	2981.84	2965.17	3006.24	3184.82

Table 2: Proximate composition of Whole Jackfruit Meal (WJM)

Nutrients	Composition
Dry Matter	92.50%
Crude Protein	11.34%
Crude Fibre	5.85%
Ash Content	4.75
Ether Extract	4.90%
Nitrogen free extract	65.55%
Metabolizable Energy	3619.61kcal/g

Table 3: Shell Growth Characteristics of *Archatina fulica* Fed Different Inclusion Levels of Whole Jackfruit Meal (WJM)

Parameter	T_1	T_2	T_3	T_4
Shell Length				
Initial(cm)	6.50	7.01	6.71	6.55
Final(cm)	6.66	7.23	7.03	6.69
Increment (cm)	0.16 $\pm$ 0.11	0.22 $\pm$ 0.31	0.32 $\pm$ 0.18	0.15 $\pm$ 0.12
Shell Aperture				
Initial (cm)	9.05	9.45	9.45	9.20
Final (cm)	9.33	9.78	9.86	9.49
Increment	0.28 $\pm$ 0.28	0.33 $\pm$ 0.37	0.41 $\pm$ 0.18	0.30 $\pm$ 0.39
Shell Girth				
Initial (cm)	3.37	3.51	3.46	3.34
Final (cm)	3.43	3.62	3.53	3.516
Increment	$0.07^{b} \pm 0.03$	$0.11^{ab} \pm 0.04$	$0.07^{b} \pm 0.02$	$0.18^{a} \pm 0.06$
Shell Thickness				
Initial (cm)	0.87	0.91	0.91	0.84
Final (cm)	1.17	1.42	1.27	1.38
Increment (cm)	0.30 $\pm$ 0.21	0.51 $\pm$ 0.11	0.36 $\pm$ 0.15	0.53 $\pm$ 0.31

Means along rows with different superscript are significantly (P<0.05) different from each other.

Table 4: Growth Performance of *Archatina fulica* Fed Different Levels of Whole Jackfruit Meal (WJM)

Parameters	T_1	T_2	T_3	T_4
Ave Daily Feed Intake (g)	0.26 $\pm$ 0.11	0.25 $\pm$ 0.98	0.31 $\pm$ 0.04	0.24 $\pm$ 0.87
Total Feed Intake (g)	12.57 $\pm$ 5.53	12.40 $\pm$ 4.8	15.27 $\pm$ 2.11	11.97 $\pm$ 4.26
Initial weight (g)	30.9	38.4	34.53	32.00
Final weight (g)	36.6	45.45	42.17	36.1
Total weight gain (g)	5.70 $\pm$ 0.14	7.05 $\pm$ 2.76	7.63 $\pm$ 1.29	4.10 $\pm$ 0.85
Ave daily weight gain (g)	0.12 $\pm$ 0.00	0.14 $\pm$ 0.56	0.16 $\pm$ 0.26	0.08 $\pm$ 0.17
Feed conversion Ratio	2.20 $\pm$ 0.61	1.76 $\pm$ 1.15	2.00 $\pm$ 0.34	2.81 $\pm$ 0.12

Means along rows with different superscript are significantly (P<0.05) different from each other.

Table 5: Cost Evaluation of *Archatina fulica* Fed Different Levels of Whole Jackfruit Meal (WJM)

Parameters	T_1	T_2	T_3	T_4
Feed Cost/g of diet (#/g)	0.170	0.163	0.156	0.148
Cost of feed intake (#/g)	2.137	2.021	2.38	1.77
Feed cost/g Weight gain (#/g)	4.701	3.557	4.76	4.974

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Comparative evaluation of effects of breed on the serum biochemical properties of rabbits

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Abstract
This study was conducted to investigate the effect of breeds on the serum biochemical parameters of three different breeds of rabbits. Thirty rabbits (both sex); 10 Chinchilla, 10 New Zealand White and 10 Dutch rabbits were used. The rabbits were reared for eight weeks and were fed pelletized commercial feed and forages ad libitum and water was provided as well. On the day of blood collection, Six rabbits (both sex) were randomly selected from each breeds (B1- Chinchilla, B2- New Zealand white and B3- Dutch respectively) and 5ml blood samples were collected from direct cardiac puncture using 5ml syringe and was drawn into a sterile tubes without anticoagulant (EDTA). The following analyses were perform on serum samples-: total protein, albumin, globulin, urea, creatinine, cholesterol, alanine aminotransferase and aspartate aminotransferase. The values of these parameters were obtained and statistical comparisons between the three breeds of rabbits were performed using complete randomized design and SPSS . From the result, no statistically significant (p>0.05) differences were found between the three rabbit breeds for the parameters analyzed. Hence, breed had no significant effect on the total protein, albumin, globulin, urea, cholesterol, creatinine, alanine aminotransferase and aspartate aminotransferase. The values obtained in this stidy were within the reference range in the literatures and other studies. Therefore, the Chinchilla, New Zealand White and Dutch breeds can be used as breeding stock in rabbit production as they are resistance to diseases and other environmental conditions.
Keywords, New Zealand white, Chinchilla, Dutch, serum biochemistry.

Introduction
The rapid growth in Nigeria population has informed the need to increase livestock production in order to satisfy her animal protein requirement. Thus, about 90% of the Nigerian populace consume less than 10g as against recommended 35g animal protein per day (Ahamefule *et al.,* 2000; FAO, 2011). This wide nutritional gap has fueled the need to intensify the production of some livestock species to address the low per capita animal protein intake by Nigerians. This shortage of animal proteins can easily be met by small animals such as rabbits, poultry and pigs. Hence, among the micro livestock of interest is rabbit, a caprophagus herbivore whose production before now has been low. Shahrbabak *et al*. (2009) and Sarikhan *et al*. (2010) maintained that rabbit production has potential of bridging the supply demand gap of animal protein in the country.
Biochemical variables of blood are generally used to monitor and evaluate health, nutritional, and physiological status of animal of which rabbit is not an exception (Al-Eissa *et al*., 2012; Gupta *et al*., 2007) and reflects the responsiveness of the animal to her internal and external environments (Esonu *et al*., 2001; Iheukwumere *et al*., 2002) and as well be used to detect organ dysfunction or diseases (Schmidt *et al*., 2007). It is also useful in selection of breeding stock that are genetically resistant to certain diseases and environmental conditions that constrains rabbit's production. It has been reported that most biochemical parameters such as glucose, total cholesterol, total protein, creatinine, blood urea, conjugated and total bilirubin, globulin, albumin, calcium,

potassium, sodium, chloride, alkaline phosphate, alanine aminotransferase, and aspartate aminotransferase) may be affected by many factors including but not limited to breed, age, feeding, environmental conditions, gender, stress and disorder (Chineke *et al*., 2006; Melillo, 2007; Jeklova *et al*., 2009). Though serum biochemical values of rabbit have been established (Karen, 2012) but It is important to establish baseline indices for these parameters on the basis of these factors and to determine the effects of these factors on these indices .None of these studies, however, has evaluated the impact of the breeds to these biochemical parameters and there is dearth of literature report on the comparative evaluation of serum biochemical indices of various breeds of rabbit especially with respect to our local feed and environment, hence this study to bridge this knowledge gap.

Material and Methods

The study was carried out at the Rabbitry Unit of the Teaching and Research Farm of College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, Abia State. Umudike is located within the tropical rainforest zone of Nigeria which is characterised by hot and humid climate and the environment is characterized by an annual rainfall of 2177mm with relative humidity of about 90% and temperature range of 22^0 - 36 ^{0}C depending on the season. Umudike bears the co-ordinates of 5^0 28 North and 7^0 31 East and lies on altitude of 122m above sea level (NRCRI, 2017).

Thirty (30) four months old rabbits of three different breeds (male and female) were used for the study. The three breeds used were Chinchilla (B1), New Zealand White (B2) and Dutch (B3) at equal proportion. The rabbits were purchased from a reputable farm at Umudike. The rabbits were certified healthy and were identified with tags. They were housed singly in rabbit hutches for ease of identification and management. Wood and wire mesh were used in constructing the hutches. The animals were provided with feeders and drinkers. The animals were fed commercial pelleted concentrate and mixed forages *ad libitum*. Clean water was provided as well. During acclimatization period that lasted for two weeks, anti-stress, antibiotics and anthelmintic drugs were administered. That is, prior to the commencement of the experiment, the rabbits were prophylactically treated against ecto- and endo-parasites by giving subcutaneous injection of 0.2 ml ivomectin per rabbit. They were equally given a broad spectrum antibiotic (Altracycline®, 0.4ml intramuscular injection per rabbit). The hutches, pens, waterers, feeders as well as the surroundings were regularly cleaned to maintain good hygiene. The experiment lasted for 8 weeks and the rabbits gained an average weight of 1.7kg, 1.90kg, 1.76kg for Chinchilla, New Zealand White and Dutch rabbits respectively. The experimental design used was Complete Randomized Design experiment (CRD).

At the end of the experiment (8^{th} weeks), five rabbits were randomly selected per breed and were restrained or immobilized and 5-ml blood samples were collected via direct cardiac puncture in the immobilized animals. This was done very quickly in order to limit the effect of acute stress on blood parameters. A 5ml syringes was used to collect the blood into sterile tubes without anticoagulant (EDTA). All blood samples were transported to the laboratory immediately. Serum was separated and frozen at -20°C for biochemical analyses.

All data collected from the field and laboratories were subjected to analysis of variance using SPSS (2013), IBM SPSS Statistics Version 22, Release 22.0.0.0. The Significant differences between breeds were separated using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

The result of the effect of breed on the serum biochemical parameters of three breeds of rabbits is presented in table 1. There was no significant ($p>0.05$) difference the serum biochemical parameters between the three breeds of rabbits. The total protein, albumin, globulin, cholesterol, urea, creatinine, alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were similar across the three breeds. However, Chinchilla (B1) breed was higher in albumin, creatinine, AST and ALT values among the three breeds whereas New Zealand White (B2) breed was maximum in total protein, globulin, creatinine and urea values.

The values ($p>0.05$) presented in Table 1 were within the range of reference values in literature and also harmonized with values reported for rabbits in previous studies (Woolf, 1991; Yazar *et al*., 2004; Silva *et al*., 2005; Elmas *et al*., 2006; Melillo, 2007). The stability of serum albumin, cholesterol, creatinine, ALT and AST concentration in rabbits across the three breeds indicates the normal physiological function of the rabbits. The New Zealand White breeds had the maximum total protein value than Chinchilla and Dutch breeds and the value is higher than the one reported by Talis *et al*. (2005) and Saad, *et al*. (2006) but lower than 5.83+-0.55 obtained by Olayemi *et al*. (2006) which could be ascribed to androgen anabolic effect. The total protein values of both Chinchilla and Dutch breeds were in accord with 4.17g/dl - 6.37g/dl observed by Okwori, (2017).

Table 1 Effect of breed on the serum biochemical parameters of breeds of rabbits

Parameters	B1(CH)	B2(NZW)	B3(DH)	SEM
Total protein (g/dl)	6.15 ± 0.31	6.22 ±0.23[a]	5.79 ±0.12	0.135 NS
Albumin (g/dl)	4.39 ± 0.15[a]	4.29 ±0.11	4.35 ± 0.14	0.715 NS
Globulin (g/dl)	1.76 ± 0.23	1.93 ± 0.21[a]	1.45 ± 0.69	0.111 NS
Urea (mg/dl)	31.56 ± 5.42	39.01± 5.23[a]	31.61± 4.61	2.891 NS
Cholesterol (mgl/dl)	20.03±1.81	24.87 ±8.75[a]	16.98 ± 4.33	3.209 NS
Creatinine (mg/dl)	1.27 ± 0.18[a]	1.26±0.17	1.24± 0.09	0.084 NS
AST (im/l)	33.80± 6.48[a]	27.54±3.33	2 t4.83±7.52	3.401 NS
ALT (im/l)	30.95± 5.04[a]	30.31±2.99	29.80±6.79	2.811 NS

NS- Not Significant, [a]: means within the row have maximum value. Where : B1- Chinchilla, B2- New Zealand White, B3-Dutch, AST- Aspartate aminotransferease, ALT- Alanine aminotransferease, SEM- Sum of error mean.

The Albumin level of 4.39± 0.15 in Chinchilla breeds (B1) was the maximum among the three breeds and there was no significant difference (p>0.05) between the three breeds. The values obtained were within the reference range for rabbit in literature even though there was an overlapping of the intervals at the upper end of the reference range indicating that the rabbits used for the study consistently outperformed those rabbits used for the reference values. This also showed that the liver, kidney and digestive system of Chinchilla, New Zealand White and Dutch rabbits were functioning well and the rabbits were not dehydrated but had an increased rate of metabolism (Azoz *et al.,* 2005). The albumin level in B1 was within the reference value for Chinchilla rabbits (Talis *et al*., 2005), but higher than the value obtained by Abdel, (2015) which could be as a result of increased metabolic rate which reflects the change in liver function.

The globulin level of Chinchilla, New Zealand White and Dutch rabbits were not significantly different (p>0.05). The values in B1, B2 and B3 were within the normal value for rabbits although there is a decrease at the lower part of the reference range obtained among the three breeds of which B3 had the lowest value 1.45±0.69, followed by B1 (1.76±0.23) and then B2 (1.928±0.209) p<0.05. The decrease could have been as a result of endocrine malfunctions (Hansen *et Al.*, 2008) and the differences indicates that New Zealand White breeds had the highest strength or ability to substitute it's feeds to fight against diseases when compared with Chinchilla breeds and Dutch breeds. The globulin value of B1, B2, and B3 were lower than the values obtained in several studies (Saad *et al*., 2016, Etim *et al*., 2011).

The serum urea nitrogen values of the three breeds were not significantly different (p>0.05). The urea value of 39.01±5.23 in New Zealand White breeds was the maximum among the three breeds, followed by B1 and then B3 (31.56±5.41 and 31.61±4.61) respectively. These urea values obtained in the three treatments were still within the normal urea reference range for rabbits even though there is an increase in the values among the three breeds of rab0.bits which may be as a result of poor kidneys functions that may result in decrease in glomerular filtration, increased catabolism of protein and persistent enzymes activities (Ajagbonna *et al.*, 1999).

The cholesterol values in B1, B2 and B3 were of no significant difference (p>0.05) among the three breeds of rabbits. The values were also within the reference range for rabbit in literature. The results also shows that rabbit breeds differ in lipid metabolism as New Zealand breeds have the maximum rate of lipid metabolism, followed by Chinchilla rabbits and then Dutch breeds. The value obtained in Chinchilla breeds were in accordance with values Obtained by Ogbuewu *et al.*

(2010) and Mohammed *et al.* (2011). B2 value was higher than the values obtained in some studies for New Zealand White rabbit (Njidda *et al*., 2010, and Burnett *et al*., 2006, Adeyeye *et al*., 2007) of which the prolonged increased could be related to the tendency to feed slightly larger slightly quantities of feed or anabolic steriods that could affect the enzymes involved in cholesterol synthesis and may result in the deposition of cholesterol in the walls of the blood vessels and subsequent heart attack as a result of blockage of important blood vessel.

The creatinine levels ($p>0.05$) observed between the three breeds were of no significant difference. The values were within the reference values for rabbits and also are in harmony with the values in literatures (Talis, 2005, Ahamefula *et al.*, 2008, Ogbuewu *et al*, 2008). Between the breeds, the creatinine values of 1.27 ± 0.18 in B1 and 1.26 ± 0.17 in B2 are the maximum while B3 (1.24 ± 0.09) was the minimum values. This results indicates that the liver where the creatinine is synthesized normal state. Hence, the rabbits where neither starved to the extent that the rabbits had to survive at the expense of their body reserve nor was there any wastage of muscle tissue among the rabbits of which B1 and B2 fully utilize their dietary protein more than B3.

The values of ALT ($p>0.05$) between the breeds showed no statistical significant difference. The values found in B1, B2 and B3 were within the normal reference range for rabbits and harmonized with values found in several studies (Simek *et al.*, 2017., Ngokere, 2014.,Talis, 2005., Ozegbe, 2005) which was an indication that the liver were not injured or damage. Between the treatments, the maximum level of ALT was obtained in B1 (30.95 ± 5.04) followed by B2 (30.31 ± 2.99) and then B3 (29.80 ± 6.79). The ALT values of the three treatments were higher than the value obtained by Ahamefula *et al.* (2008) which could be a sign of necrosis and myocardic infarctions that may be indictors of poor protein of diets fed to the rabbits. B2 value was lower than value of Olayemi *et al.* (2007).

AST values was maximum in B1 and B2 while B3 was the minimum although all the values falls within the reference range for rabbits and are similar with other studies (Ozcan, 2005., Ngokere, 2014., Talis, 2005.) which dictates that the cardiac and skeletal muscles were not damaged which could have resulted in the release of these enzymes into the blood thereby increasing their levels in the blood.

Conclusion

The findings of this study proved that the serum biochemical parameters investigated among the three pure rabbits breeds were not significantly different ($p>0.05$). The values were within the reference ranges in the literature and harmonized with several studies. Hence, the total protein, albumin, globulin, urea, creatinine, cholesterol, AST and ALT were within the normal reference range for rabbits. Therefore, the Chinchilla, New Zealand White and Dutch breeds can be used as breeding stock in rabbit production as they are resistance to diseases and other environmental conditions.

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Effect of garlic rhizome (*Allium sativum*) powder supplemented diets on the haematology and serum biochemistry of broiler birds at different growth phases

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Abstract
This study was carried out to evaluate the effect of garlic rhizome powder on blood profile of broiler at different growth phases (starter and finisher phase). One hundred and twenty Abor acre broiler chicks were used for the study and the chicks were randomly distributed into four treatment groups and the treatment groups were then divided into different replicates with each replicate having 10 chicks i.e. 30 chicks in each treatment group. The garlic powder was included at different inclusion levels and the treatments were designed as T_1: basal diet with no garlic powder, T_2: basal diet supplemented with 0.5% garlic powder T_3: basal diet supplemented with 1.0% garlic powder and T_4 having 1.5% garlic powder. Starter diet was offered to the birds for the first four weeks of the feeding trial and finisher diet was also provided for the birds within 5^{th} to 8^{th} week. Daily feed intake and weekly body measurement were taken. At the end of the starter phase, blood was collected for haematological and serum biochemistry analysis also blood was collected for blood profile analysis at the seventh (7^{th}) week of the experiment. The blood samples collected were analyzed for haematological parameters which include haemoglobin, Packed cell volume, Red blood cells, White blood cells, Mean corpuscular haemoglobin, Mean corpuscular volume, Mean corpuscular haemoglobin concentration, heterophils, lymphocytes, monocytes, eosinophils and serum biochemical parameters which include Aspartate aminotransferase, Alanine aminotransferase, Alkaline Phosphate, Cholesterol, Total protein, Albumin, Globulin, Uric acid and Creatinine. Results showed that the effect of feeding graded levels of garlic rhizome powder on the haematological and serum parameters were significant ($P<0.05$). The cholesterol levels of experimental birds dropped significantly with increasing levels of garlic in the diets. Inclusion of garlic powder on broiler feed had no significant difference ($P>0.05$) on the creatinine level. Therefore 1.5% inclusion of garlic should be added to broiler feed to enhance production of broiler lean meat with lowest cholesterol

Introduction
Poultry meat has been regarded as the second largest global food commodity (Manning, 2007). High cost of feed ingredients and disease outbreak are factors limiting poultry production in the tropics, hence the need for the use of cheap feed ingredients and antibiotics (Mellon, 2000).
Additives are added in poultry feed to improve nutritive value of ingredients and enhance broiler performance by promoting growth rate and improving feed efficiency. Antibiotics growth promoters (ABGP) have been intensively used in broiler production to improve productivity. However, they are notorious for alteration of natural gut micro biota and drug resistance in bacteria and their negative impacts on the consumers' health(Sharma, 2007).
There have been negative effects of using synthetic antibiotics on humans' health and subsequent reduction in haematological and serum parameters in broilers would predispose the animals to reduced immunological responses to infection. The European union banned antibiotic growth promoters owing to its cross resistance, also to the risk of possible drug multiple resistances in

human pathogenic bacteria. Again high cost of these growth enhancers and their technicalities involved in their use for improving broiler growth reduces their usage by farmers.

Some consumers are aware of the residual effects of antibiotics in poultry meat that is the reason organic poultry products is the consumer's preference, hence the search of alternative natural growth enhancers such as plants and their extracts. Medicinal plants contain many useful substances, some of which are biologically active. These substances can be used for therapeutic purposes and have been applied for several decades to serve as precursors for the synthesis for new drugs (Evans, 2002).

Garlic has been used as a spice and a native medicine for many years. It posses antibacterial, antifungal, anti-cancerous characteristics. Garlic supplement in broiler chicken diets have been recognized for their strong stimulating effect on the immune and digestive system in birds.

The use of blood examination as a way of assessing the health status of animals has been recorded. This is because it plays a vital role in physiological, nutritional and pathological status of organisms. Hematological parameters are those parameters that are related to the blood and blood forming organisms. It has been reported that biochemical changes as a result of toxins have effect on the haematological parameters. They are thus used to determine systemic relationships and physiological adaptations in the body of animals exposed to toxicants and stresses due to environmental nutritional and pathological factors.

Materials and Methods

This study was carried out at the Poultry unit of Teaching and Research farm of the department of Animal science and Technology, Faculty of Agriculture, Nnamdi Azikiwe University, Awka, Anambra state. The location lies between latitude 6.24^0N & 6.28^0N and longitude 7.00^0E and 7.08^0E on the south eastern part of Nigeria, the climate is the tropical wet and dry type with a clear season, the mean daily maximum temperature is usually 27^0C all over the year although could reach 34^0C in March and lowest during the harmattan months of December and January. The mean annual rainfall according to the local Metrological Station which has maintained records since 1978 reveals a mean rainfall of about 1600mm with a relative humidity of 80% at dawn (Ezenwaji *et al,* 2013).

The test ingredient **(**Garlic bulbs) were purchased from Eke Awka market in Anambra State. The bulbs were chopped into tiny cuts, sundried for three weeks and then oven dried at temperature of 50^oC for 15 hours and then ground into powder. The powder obtained was further dried under sun for proper desiccation. Four experimental diets for starter and finisher broilers were formulated as T_1 (control, with no garlic powder supplementation), T_2, T_3 and T_4 which contained 0.5%, 1.0% and 1.5% of garlic powder respectively as shown in table 1 (starter diet) and 2 (finisher diet). One hundred and twenty Abor acre broiler chicks of mixed sexes from FIDAN farm Ibadan North, Oyo state were used for the experiment. The chicks were randomly assigned to four (4) treatment groups with three replicate per treatment and each replicate having a number of 10 birds.

Few days to the arrival of the chicks, the brooding pen, drinkers and feeders were disinfected. The birds were raised on a commercial starter mash for 2 (two) weeks together in one pen after which they were divided into different treatment groups with each treatment group having a total of thirty birds (30) each and the different replicates with each replicate having 10 birds each. Birds were housed under deep litter system. Kerosene stoves and lantern were used to provide heat needed to keep the temperature within the temperature range of 33-35^{o}C. Feed and water were given to the birds *ad libitium* usually in the moving and evening. The birds were weighed at the beginning of the trial to get their initial weight and thereafter, weekly weight again were taken. Daily feed intake was determined by weighing the feed offered and the leftover the following morning. The feeding trial lasted for 8 (eight) weeks. The birds were vaccinated at appropriate time and litter changed at appropriate time.

Blood samples were collected from two broiler birds per replicate at fourth week of the feeding trial and the eight (8) week i.e at the end of the feeding trial through the wing vein using 5ml sterilized syringe.

About 2.5ml of blood samples per bird were collected into sterilized bottles containing (EDTA) ethylene diamine tetra acetic acid which is the anti-coagulant which were used for determining the hematological parameters and the second set of bottle without EDTA were used for collection of

blood for biochemical analysis and about 2.5ml of blood from each bird were collected for serum biochemical analysis. Blood samples for haematology were analyzed for haematololgical parameter which include haemoglobin, packed cell volume, red blood cell, white blood cell, heterophils, lymphocytes, eosinophils, monocytes, mean corpuscular haemoglobine concentration (MCHC), mean corpuscular volume (MCV) and the blood samples for serum biochemical analysis were analyzed for total protein, Albumin, globulin, vin acid cholesterol, creatinine, glucose, Aspartate aminotransferase (AST), Alamine aminotransferase (ALT), Akaline phosphates serum was harvested from blood by centrifugation and kept inside the freezer until when needed for biochemical analysis.
Data generated were subjected to analysis of variance using the linear model procedure of the SAS (2000). A probability of (P<0.05) was considered to be statistically significant using Duncan multiple range test of the same package.

Table 1: Gross composition of starter broiler diet with graded levels of dried garlic powder

Feed ingredients (kg)	Diet 1	Diet 2	Diet 3	Diet 4
Maize	54.00	54.00	54.00	54.00
Wheat offal	6.00	5.50	5.00	4.50
Soya bean meal	25.00	25.00	25.00	25.00
(PKC) palm kernel cake	8.00	8.00	8.00	8.00
Fish meal	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25
Garlic	-	0.50	1.00	1.50
Salt	0.25	0.25	0.25	0.25
Total	100	100	100	100
Crude protein	23.50	23.45	23.42	23.40
Me (kcal/kg)	3005.00	3004.95	3004.85	3004.74

Table 2: Composition of experimental finisher diet with graded levels of dried garlic powder

Feed ingredients (kg)	Diet 1	Diet 2	Diet 3	Diet 4
Maize	55.00	55.00	55.00	55.00
Wheat offal	10.00	10.00	10.00	10.00
Soya bean meal	22.00	22.00	22.00	22.00
(PKC) palm kernel cake	6.00	5.50	5.00	4.50
Fish meal	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00
Garlic	-	0.50	1.00	1.50
Salt	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Total	100	100	100	100
Crude protein	19.50	19.55	19.51	19.50
Me (kcal/kg)	2971.90	2971.89	2972.16	2971.98

Results and Discussion

The results of the haematologial indices of starter and finisher broiler is presented in table 3 and 4 respectively. Packed cell volume, red blood cells and the haemoglobin at both the starter and finisher phase were significantly (P < 0.05) among the treatment groups. The significant variation in red blood cells, packed cell volume and haemoglobin indicates that garlic powder had an effect on normal erythropoiesis and transportation of oxygen, chemicals and nutrients essential for life. This findings opposes the report of Elaglb *et al*, (2013) who reported non-significant (P>0.05) effect of garlic powder inclusion at 3 and 5% level on PCV, RBC, Hb. Mmerole, (2004) reported that haemoglobin and packed cell volume levels are normally higher in a well-nourished than poorly

fed animal. The increase in PCV, Hb and RBC levels of birds fed the test ingredient is an indication of improved oxygen carrying capacity of the cells which translated to a better availability of nutrients to the birds consequently affecting their well-being (Elaglb *et al*., 2013). Aengwawich *et al*, (2003) reported that deviation of packed cell volume from normal is an indication of anemia in birds and packed cell volume decreases when chickens are exposed to heat stress. The decrease in haemoglobin content in broilers at the finisher phase may be due to the presence of some hemolytic bioactive constituents in garlic. This report agrees with findings of Fadlalla *et al*, (2010), Onyimonyi *et al*, (2013) and Jawad, (2007) who reported that value of haemoglobin content of broilers was found to be insignificantly lowered in garlic treated groups.
At both starter and finisher phases, there were significant difference (P < 0.05) in the white blood cells. The increase in white blood cells at both phases indicates the Immuno-stimulant properties of garlic (Oluwole, 2001).This is in contrast with findings reported by George-Gay and Parker, (2003) who established that decrease in white blood cells was as a result of decreased production in the bone marrow or destruction due to viral infections or toxic reaction.
The mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) showed significant difference (P < 0 .05) among the treatment groups. This may be due to the defense reaction against *Allium sativum* which occurs by stimulation of erythropoiesis (Sealant *et al.*, 2006). From the findings, lymphocytes, monocytes, eosinophils and heterophiles showed significant difference (P < 0.05) at both phases. Iraql, (2014) reported improvement of broiler chicken immune system and significant increase of lymphocytes, heterophiles with garlic extract supplementation due to immuno-stimulant effect of garlic. At both phases the mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration decreases at an increasing rate at both phases.

The results of the biochemical indices of starter and finisher broiler is presented in table 5 and 6 respectively. There was significant difference in the cholesterol percentage. The result showed that broiler chickens fed diet 1 (0% GP) were significantly higher (P < 0.05) than those fed diet supplemented with garlic at various inclusion level. This result showed that as the inclusion level of garlic increases, there was more reduction in cholesterol percentage. This result corresponds with findings reported by Mansomb, (2011) who reported reduction in total cholesterol with broilers supplemented with 1g/kg of garlic. Stanacev *et al*, (2011) reported that garlic manifested hypocholesterolemic effects on chicken through inhibition of the most important enzymes that participate in the synthesis of cholesterol and lipid. At the finisher phase there is increase in cholesterol level, there is significant different (P<0.05) among the treatment group. This is in agreement with findings of Benjamin *et al*, (1987) that carried out a research on dogs reported elevation in cholesterol level in the blood but after 4-5 months decreased. This researcher attributed this to the effect of garlic on gradual release of cholesterol from its storage places which leads to elevation of cholesterol level, then decreased when storage is exhausted. From the result it was observed that the level of Aspartate amino-transferase (AST), Alanine amino transferase and Alkaline phosphate (ALP) decreases significantly (P<0.05) except for treatment group with inclusion level of 1.5% garlic rhizome powder which shows increase in ALP. This result agrees with the finding reported by Jimoh *et al*, (2012) who observed that supplementation of garlic reduced the serum levels of aspirate amino transferase and Alanine aminotransferase indicating the supplementation has no toxic effects on the liver.

Zinkl, (1986) reported that usually low levels of Aspartate amino transferase are normally found in the blood poultry birds but when high levels are found (400-4000 unit/μ) there is likely to be cases such as viral hepatitis and carbon tetrachloride poisoning. Also this result correlates with result of Kumar et al, (2013) who observed that serum of glutamate oxaloacetate transaminase (SGOT) and serum glutamine pyruvate transaminase (SGPT) concentration decreases significantly (P <0.05) of broiler due to Allium sativum supplementation in different treatment group compared to control group at 28th and 42nd days. Reduction in AST level indicates improvement in live function. At the starter phase, the total protein showed broiler chicken fed diet 1 (0%GP) have the higher value of total protein than other groups. The result showed significant different exist in the total protein, Albumin, Globulin, uric acid across treatment groups at both phases. At the starter phase, there is a decrease in the total protein while at the finisher stage, the result showed increase in total protein. The blood protein and creatinine depends on the quality of dietary protein. Form the result, the increase in the total protein showed beneficial synergistic effect of phenolic and flavonoids on protein metabolism. The higher albumin level observed in birds fed garlic powder at the finisher phase confers a positive result as albumin is responsible for delivering important nutrients to body cell and also prevents cell damage.

From the result, there was no significant difference (P> 0.05) in creatinine at both starter and finisher phase. This indicates that supplementation of garlic powder has no effect on the muscle wastage of broiler chicken. Higher creatinine indicates poor utilization of nutrient due to muscle wastage but from the result above, there is no significant difference among treatment group.

There was significant difference in glucose and uric acid at both phases. At the starter phase, there was increase in glucose level as the level of inclusion of garlic powder increases while at the finisher phase, there was decrease order of glucose level. The glucose level of broiler chicken fed diet 1(0% GP) is higher than other groups while at the starter phase, the glucose level of broiler chicken fed diet 4(1.5%GP) is higher than other groups. The reduction in glucose level at the finisher phase agrees with the findings of Shalaby *et al*, (2006) and Daoud, (2003) who observed reduction in serum glucose concentration due to garlic supplementation and this may be due to allicin and sulphur compounds of garlic.

Conclusion

Garlic is a feed additive which can be added in the diet of broiler without any harmful effect. This study proved that 1.5% inclusion of garlic has the highest reduction effect on cholesterol, also the addition of garlic powder in broiler diet does not have any effect on the creatinine level of the broiler birds. Therefore 1.5% inclusion of garlic should be added to broiler feed to enhance production of broiler lean meat with lowest cholesterol.

Table 3: Haemotological indices of starter broiler diets supplemented graded level of garlic powder

Parameters	T1	T2	T3	T4
Haemaglobin (g/dl)	9.38±.02^{d}	10.27±.02^{c}	9.77±.063^{b}	11.05±.05^{a}
Packed cell Volume (%)	27.83±.10^{c}	28.83±.10^{b}	28.00±1.0^{bc}	31.33±.10^{a}
Red Blood Cell(x10^{12}/l)	1.46±.10^{b}	1.57±.10^{b}	1.52±.04^{b}	1.82±.10^{a}
White Blood Cell (x10^{12}/l)	3.10±.10^{d}	4.87±.10^{b}	5.48±.10^{a}	4.23±.10^{c}
MCV (FI)	19.19±.02^{b}	19.31±.02^{a}	18.66±.06^{d}	18.84±.05^{c}
MCH (pg)	64.16±.02^{b}	65.28±.02^{a}	63.46±.05^{c}	60.88±.06^{d}
MCHC (g/dl)	33.37±.02^{c}	33.80±.02^{b}	34.14±.05^{a}	32.37±.05^{d}
Hetero Phils(%)	66.17±.02^{a}	62.64±.02^{c}	63.50±.10^{b}	60.17±.05^{b}
Lympho Cytes(%)	30.83±.01^{d}	33.62±.20^{b}	32.50±.05^{c}	35.50±.05^{a}
Eosino Phils(%)	2.83±.03^{d}	3.07±.04^{c}	3.17±.0^{b}	3.33±.03^{a}
Monocytes (%)	0.170±.01^{d}	0.663±.01^{c}	0.830±.03^{b}	1.000±.01^{a}

Table 4: Haematological indices of finisher broilers fed diets supplemented with garlic rhizome powder

Parameters	T_1	T2	T3	T4
Haemoglobin	9.80 ± 0.05^a	8.80 ± 0.02^b	7.62 ± 0.03^c	7.37 ±0.03^d
PCV (%)	31.89 ± 0.06^a	29.65 ± 0.20^b	26.50 ± 0.10^d	26.80 ± 0.03^d
RBC (10^6/μl)	1.70 ± 0.08^a	1.58 ± 0.80^{ab}	1.45 ± 0.03^{bc}	141 ± 0.09^c
WBC (103/μl)	2.46 ± 0.05^b	3.33 ± 0.07^c	4.50 ± 0.05^b	6.05 ± 0.05^a
Mean corpuscular volume (FL)	19.26 ± 0.05^b	19.67 ± 0.07^a	18.94 ± 0.06^b	18.83 ± 0.06^d
Mean corpuscular haemoglobin (MCH)	57.84 ± 0.04^b	58.44 ± 0.04^a	52.80 ± 0.10^d	53.57 ± 0.03^c
Mean corpuscular haemoglobin concentration (MCHC) (g/dl)	57.84 ± 0.04^a	29.82 ± 0.10^b	27.85 ± 0.10^d	28.62 ± 0.01^c
Lymphocytes	32.23 ± 0.10^b	3.34 ± 0.08^a	32.21 ± 0.10^b	32.17 ± 0.10^b
Monocytes	1.67± 0.01^a	1.00± 0.00^b	1.00± 0.00^b	1.00± 0.01^b
Eosinophils	3.0 ± 0.20^a	3.33 ± 0.10^b	3.33 0.10^b	1.00± 0.10^a
Heterophils	64.10 ± 0.10^a	62.33 ± 0.11^c	63.4933 ± 0.09^c	63.83 ± 0.03^b

Table 5: Serum biochemical indices of starter broiler chicken fed graded levels of garlic powder

Parameters	T1	T2	T3	T4
ALT	34.35 ± .18^a	29.66±.21^b	27.53±.31^d	29.51±.43^c
ALP	48.47±.27^a	45.17±.03^c	48.24±.07^a	47.53±.26^b
AST	124.52±.18^a	122.66±.21^b	115.51±.29^d	116.31±.13^c
Cholesterol	96.28±.34^a	92.76±.68^b	90.49±.38^c	90.43±.38^d
Glucose	137.83±.03^c	135.37±03^d	139.17±.08^b	145.54±.12^a
Total protein	68.28±.10^a	63.16±.04^b	61.33±.03^c	60.67±.03^d
Albumin	42.33±.10^a	38.52±.03^b	37.45±.03^c	37.30±.03^d
Globulin	25.95±.10^a	24.67±.04^b	23.88±.03c	23.37±.03^d
Uric	40.67±.03^b	39.05±.05^c	36.83±.03^d	41.05±.05^a
Creatinine	0.67±.02	0.74±.02	0.71±.02	0.71±.04

Table 6: The serum biochemical indices of finisher broilers fed diets supplemented with garlic powder

Parameters	T1	T2	T3	T4
ALTU/L	16.28 ± 0.03^a	15.47 ±0.07^b	13.81 ± 0.03^d	15.15 ± 0.05^c
ALP (μL)	48.8233 ± 0.08^a	43.50 ± 0.10^b	41.67 ± 0.10^c	40.67 ± 0.10^d
AST (μ/L)	143.17 ± 0.03^a	138.50± 0.05^c	140.60 ± 0.07^b	140.55 ± 0.05^b
Cholesterol (mg/dl)	90.26 ± 0.70^a	1.7933 ± 0.22^c	92.75 ± 0.70^b	95.30 ± 0.30^a
Glucose (mg/dl)	165.67 ± 0.03^a	161.40 ± 0.10^b	152.83 ± 0.05^d	158.59 ± 0.90
Total protein	56.00 ± 0.10^c	55.33 ± 0.11^d	62.50 ± 0.20^b	63.17 ± 0.03^a
Albumin	34.50 ± 0.10^c	35.80 ± 0.03^b	37.67 ± 0.10^a	35.67 ± 0.03^b
Globulin	21.50 ± 0.05^c	19.50 ± 0.05^d	24.83 ± 0.03^b	27.50 ± 0.05^a
Uric acid (Mg/dl)	48. 17± 0.03^d	48.25± 0.04^c	64.83± 0.03^b	72.67± 0.03^a
Creatinine (mg/dl)	1.58 ± 0.90	1.17 ± 0.03	1.17 ± 0.01	1.45± 0.03

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Effect of aqueous extract of Cocoyam leaf (*Xanthosoma sagittifolium*) on the growth performance of broilers fed full-fat soya bean.

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Abstract
This experiment was conducted to investigate the effect of aqueous extract of cocoyam leaves (Xanthosoma sagittifolium) on the growth performance of broilers fed full-fat soya bean based diet. A total of 120 unsexed day old Abor acre chicks were used for the experiment. The chicks were randomly assigned to four treatment groups (T_1, T_2, T_3, T_4) with three replicates of ten birds per replicate and 30 birds per treatment in a Complete Randomized Design. The birds were given equal quantity of formulated feed and subjected to similar managerial and sanitary conditions so that the only source of variation was the concentration of aqueous extract of cocoyam leaves offered to the birds. T_1 which served as the control contained 0g of cocoyam leaves aqueous extract, T2 (100g cocoyam leaves aqueous extract), T3 (150g cocoyam leaves aqueous extract) and T4 (200g cocoyam leaves aqueous extract) were offered per 6 litres of water to the experimental birds for a period of 56 days. During this experimental period, feed intake, body weight and water intake were monitored. The feed intake and body weight gain were used to calculate feed conversion ratio. Data collected were analysed using Analysis of Variance (ANOVA) for Completely Randomized Design, while the means were separated using least significant difference ($P < 0.05$). The result showed that there was no significant (P>0.05) difference in the feed intake, weight gain and feed conversion ratio of broiler chicks treated with aqueous extract of cocoyam leaves. However, the daily intake of water differed significantly (P>0.05), T_1 recorded higher value followed by T_2, T_3, T_4 and T_5. From the findings of this study, broiler birds can be subjected to aqueous extract of cocoyam leaves at the inclusion levels of 100-150g of cocoyam leaves per 6 litres of drinking water without any negative effect on the weight gain.

Keywords: Xanthosoma sagittifolium, aqueous extract, cocoyam leaf, Abor acre, cocoyam leaves, performance

Introduction
Animal protein is essential for human health and development but its availability for human consumption especially in developing countries has become a mirage (Onilude and Oso, 1997 as cited by Omoikhoje, 2017). The Nigerian population and the overall demand for animal protein is growing at an alarming rate while the current animal protein production is growing at a decreasing rate much below the population growth rate and animal protein demand. This portrays a situation of hunger for animal protein and so to effectively combat this malnutrition and under-nourishment, FAO/WHO recommended a minimum of 65g of protein per person per day of which 35g (53.8%) must come from animal sources or 12.8kg per person per annum. (Lamorde, 2008). According to Adegbola (1990) as cited by Inyang *et al.* (2014), only 8.2g of animal protein is consumed per person per day by an average Nigerian which goes a long way to indicate that about 60 – 80 percent of Nigerians are malnourished. The problem of animal protein production shortage in Nigeria is attributed to the fact that the human population is growing at 2.8%per annum (NBS, 2010) while that of animal population is growing at 1.8%per annum (Ilu *et al.,* 2016). Therefore, only an optimum animal production will help to alleviate this situation. Besides, massive

production of prolific animals like swine is limited by challenges of religious and socio-cultural prohibitions. Meanwhile, poultry animals and products have been considered to be one of the options in Nigeria for reducing the incidence of this malnutrition particularly animal protein shortage in diets of populace because of its ability to provide a good supply of protein, essential vitamins, and minerals, regulating cholesterol and blood pressure. However, these poultry animals that have high generation interval are also challenged by high cost of feed ingredients and feeds, thereby causing an impediment on the increase in animal protein supply. Apart from the problems associated with production cost, poultry meat is also associated with fat deposition.
In recent times corn/soya feed mix has been the practice in most feed formulating industries (NRC, 1994), but the fat related diseases and disorders such as atherosclerosis, high blood pressure, high cholesterol, heart diseases, cancer, obesity, resulting from such meat is making a lot of people to search for meat with less fat content (lean meat). Thus, the need to access the possibility of minimizing fat deposition using readily available feed additives. Cocoyam leaves appear to have the potential to reduce the fat deposition in animals raised on corn/soya mixture.

Materials and Methods

This study was carried out at the Teaching and Research Poultry unit of the Department of Animal Science and Technology, Faculty of Agriculture, Nnamdi Azikiwe University, Awka, Anambra State. The location lies between Latitude 6.24^{0}N and 6.28^{0}N and longitude 7.00^{0}E and 7.08^{0}E on the South Eastern part of Nigeria, the climate is the tropical wet and dry type with a clear season, the mean daily maximum temperature is usually 27^{0}C all over the year although it could reach 34^{0}C in March and lowest during the harmattan months of December and January (Ezenwaji *et al,* 2013).
A total of one hundred and twenty (120) day-old broiler chicks of Abor acre breed were procured from Zartech farm, Ibadan and was transported to the Teaching and Research Farm of the Department of Animal Science and Technology, Nnamdi Azikiwe University, Awka in the early hours of the morning in order to minimize heat stress. The birds were fed with commercial broiler starter for one week. to ensure their acclimatization to the new environment before the commencement of the experiment. Prior to the arrival of the birds, the brooding pens were kept in good condition for brooding together with the feeders, drinkers and heat source. The full fat soya used for the experiment was purchased from Nnobi village market in Anambra State. The sand, debris and all unwanted components in the seeds were removed by hand picking, thereafter, the full-fat seeds was heat treated by roasting in an open pan for forty-seven (47) minutes to reduce anti-nutritional factors and enhance digestibility. The roasted full fat soya was further processed by milling using a locally fabricated milling machine model before incorporation into experimental diets. The cocoyam leaves were collected from the local farmers at Uga in Anambra State and air-dried for seven (7) days in a room using a ceiling fan. Thereafter, the dried plant materials were ground using a locally fabricated hammer milling machine and then stored in air- tight container. 100g, 150g and 200g of ground air dried plant material powder were separately macerated in drinking troughs each containing six litres of water. Aqueous extract of *Xanthosoma sagittifolium* leaves were obtained by sieving the sediments from the liquid using a sieve. The chicks were randomly assigned to four treatment groups (T1, T2, T3, T4), each treatment with three replicates such that each treatment had 30 chicks replicated three times with 10 chicks per replicate in a Complete Randomized Design. T1 which served as the control contained 0g of aqueous extract of cocoyam leaves, while birds on T2, T3, and T4 were offered aqueous extract of cocoyam leaves at 100g, 150g and 200g per 6 litres of water respectively. An experimental diet was prepared using full fat soya bean to ensure the broiler chicks were given feed that will allow fat deposition. The gross composition of the diet is shown in table 1.

Results and Discussion

The proximate composition of cocoyam leaves (*Xanthosoma sagittifolium)* and the four experimental diet are presented in Table 2 and 3 respectively. The result showed that cocoyam leaves (*Xanthosoma sagittifolium*) have crude protein content of 15.53% and gross energy of 2990.36kcal/kg. Thus, it can serve as a feed ingredient in poultry nutrition. The experimental diet has crude protein of 19.70%, crude fat of 5.60% and gross energy of 2910.76kcal/kg. The mineral composition of cocoyam leaves (*Xanthosoma sagittifolium)* is presented in Table 4. Cocoyam leaves (*Xanthosoma sagittifolium*) have high content of potassium 220.05 mg/100g, sodium 192.06

mg/100g, phosphorus 150.40 mg/100g, calcium 130.18 mg/100g. This collaborated with the findings of Chukwu, *et al.* (2008); Ekwe, *et al* 2009; Lim, 2016; Opara, 2003 who stated that cocoyam leaves have high Calcium, Phosphorus, and Magnesium content and also with the findings of Holloway, (1988) as cited by Boakye *et al.* (2018) that cocoyam leaves are high in potassium content. The phytochemical composition of cocoyam leaves (*Xanthosoma sagittifolium)* is presented in Table 5. The result showed flavonoid content of 2.90, Tannin content of 1.28, Alkaloid content of 9.60, Steroid content of 0.61, Phenol content of 230.40, Cyanide content of 0.21, Phytate content of 1.19 and Oxalate content 0.07. This collaborated with the findings of Apata and Babalola (2012). Cocoyam leaves (*Xanthosoma sagittifolium*) have high content of phenols (230.40mg/100g) which are important antioxidants in plants and thus can be explored in food and pharmaceutical industries.

The effect of aqueous extract of cocoyam leaves on growth performance of broiler birds is presented in Table 6. There is no significant (P>0.05) difference in the feed intake of broiler birds treated with aqueous extract of cocoyam leaves. The lower quantity of feed intake recorded in T_2 could be due to the lower crude protein content of the aqueous extract of cocoyam leaves (at 100g inclusion). This study collaborated with the findings of Giang, (2010) where the total dry matter intake was highest on the treatment on ducks when fed 7% of live weight of taro leaves mixed with a mineral-premix. There was no significant (P>0.05) difference amongst the treatments on the weight gained by the broiler chicks. This agrees with the findings of Giang, (2010) on his experiment conducted to evaluate the effect of taro silage (made from leaves and stem of *Coloscasia esculenta*) and rice bran on the growth performance of ducks. There is no significant (P>0.05) difference in the feed conversion ratio of broiler chicks treated with aqueous extract of cocoyam leaves. This collaborated with the findings of Giang, (2010) who reported that there was no significant effect on feed conversion ratio of including a mineral-premix when taro leaves were fed. There is no significant (P>0.05) difference in the feed efficiency of broiler birds treated with aqueous extract of cocoyam leaves. There is no significant (P>0.05) difference in the specific growth rate of broiler birds treated with aqueous extract of cocoyam leaves There is significant (P<0.05) difference amongst the treatments on the total and mean daily water intake by the broiler chicks. T_1 had the highest water intake while T_5 had the lowest water intake following a decreasing trend. This could be due to the fact that cocoyam leaves contains tannin (anti-nutrient) and thus increases with increase in cocoyam leaves inclusion in the treatments. Thus, as stated by Haslam, (1989) as cited by Ndyomugyenyi, (2016) that tannins are astringent, bitter-tasting plant polyphenols which by implication reduces the free water intake of the bird.

Conclusion

The proximate and mineral analysis of cocoyam leaves showed that cocoyam leaf possessed appreciable quantity of nutrients and minerals and can serve as a source of feedstuff in livestock nutrition. It is also safe to say that broilers could be subjected to aqueous extract of cocoyam leaves and should be included between the levels of 100-150g per 6 litres of water without any negative effect on the weight gain.

Table 1: Gross composition of the experimental diets

Ingredients	Inclusion (%)
Maize	58.00
Full-fat soya	26.5
Fish meal	4.00
Dry brewer's grain	5.00
Palm oil	2.00
Bone meal	2.50
Limestone	0.50
Salt	0.50
Methionine	0.30
Lysine	0.20
Vit/min Premix	0.50

Table 2: Proximate composition of cocoyam leaves.

Constituents	Composition
Nutrient	
Crude protein (%)	15.53
Crude fat (%)	9.60
Crude fibre (%)	17.41
Ash (%)	11.60
Nitrogen free extract (%)	37.71
Dry matter (%)	91.15
Moisture (%)	8.15
Gross energy (kcal/kg)	2990.36

Table 3: Proximate Composition of the Experimental diet.

Nutrient	Composition
Crude protein	19.70%
Crude fat	5.60%
Crude fibre	7.55%
Ash	5.13%
Nitrogen free extract	52.59%
Dry matter	90.57%
Moisture	9.43%
Gross energy	2910.76kcal/kg.

Table 4: Mineral composition of cocoyam leaves

Minerals	Composition (mg/100g)
Magnesium	68.06
Calcium	130.18
Phosphorus	150.40
Sodium	192.06
Potassium	220.05
Iron	0.07
Zinc	0.08
Copper	0.04
Manganese	0.05

Table 5: Phytochemical Composition of cocoyam leaves

Parameter	Composition (mg/100g)
Flavonoids	2.90
Tannins	1.28
Alkaloids	9.60
Steroids	0.61
Phenols	230.40
Cyanide	0.21
Phytate	1.19
Oxalate	0.07

Table 6: Effect of Aqueous Extract of Cocoyam Leaves on Growth Performance of Broiler Chicks.

Parameters (per bird)	T1	T2	T3	T4	SEM
MIW	223.56	258.77	228.06	241.33	0.57
TFI	3329.89	3197.17	3229.22	3325.5	1.69
MDFI	79.28	76.12	76.88	79.18	0.36
MFW	1246.39	1195.22	1238.89	1182.76	1.18
MDWG	24.35	22.30	24.07	22.08	0.52
FCR	2.67	2.68	2.61	2.96	0.11
FE	0.31	0.29	0.31	0.26	0.02
SGR	0.17	0.16	0.16	0.16	0.19
TWI	2.76[a]	2.51[b]	2.32[c]	2.07[d]	0.48
MDWI	0.15[a]	0.14[b]	0.13[c]	0.12[d]	0.21

MIW – Mean initial weight, TFI-Total feed intake, MDFI Mean daily feed intake, MDWG – Mean daily weight gain, MDWI– Mean daily water intake.

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Effect of breed on semen biochemical parameters of rabbit bucks

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Abstract
This study was conducted to evaluate the effect of breed on the semen biochemical parameters of three breeds of adult rabbits. Three breeds (Chinchilla breed, Dutch breed and New Zealand White) were used. Ten rabbit bucks were used per treatment, and were housed individually in hutches. The experiment lasted for eight weeks. Semen samples were collected using artificial vagina (AV) for evaluation of semen biochemical parameters. Complete Randomized Design experimental design was used. Thus, the experiment was conducted using one way analysis of variance (ANOVA) and differences between treatments means were separated using Duncan New Multiple Range Test. The biochemical parameters analyzed were total protein, albumin, globulin, initial fructose, total cholesterol, total phospholipids, total calcium, total lipids, Alanine aminotransferase and alkaline phosphatase. The results obtained showed that there were significant ($p<0.05$) differences in total protein, initial fructose, total phospholipids and alanine amino transferase between the breeds. There were no significant ($p>0.05$) differences between the breeds in albumin, globulin, total cholesterol, total calcium, total lipids, aspartate amino transferase and alkaline phosphatase. From the findings of this study Chinchilla breed had the highest values in five parameters-.total protein, globulin, initial fructose, total phospholipids and total lipids. Dutch breed had the highest values in total calcium. New Zealand White had the highest values in albumin, total cholesterol, aspartate amino transferase, alanine amino transferase and alkaline phosphatase. Chinchilla and New Zealand white had the highest values in the different biochemical parameters and are therefore, recommended for the production of genetically superior rabbit with good quality semen

Introduction
Inadequate animal protein in the diets of people in developing countries has called for the integration of some micro livestock in the farming system as sources of animal protein. Increase in the rabbit production is one way of meeting the animal protein requirements of the Nigerian populace (Iyeghe-Erakpotobor *et al*, 2002). Rabbits have high efficiency in the production of meat compared to other farm animals; thus are considered good source of animal protein. Also rabbit production is amenable to all levels of production, and therefore the field of investment of rabbit production is available for everyone especially young people. Rabbit production has a lot of benefits among which are: high adaptability, easiness to handle and manage, high growth rate, high efficiency in converting forage to meat, short gestation period and very high prolificacy (Aduku and Olukosi 1990 and Onifade *et al*., 1999). It also provides high returns on investment, produces high quality meat products which contains high protein level of about 20.8%, low sodium, low fat and cholesterol levels .It is used for laboratory processes and as pets and its faeces is a good source of manure, and its consumption is without cultural and religious biases (Biobaku and Oguntona, 1997; Omole *et al*., 2005). The presence of caecal microbes enables the rabbit to digest large amounts of fibrous feed as most non ruminant species cannot (Taiwo *et al*., 1999). Costs of beef, chevon, mutton, chicken and frozen fish are high compared to rabbit meat (Aduku and Olukosi, 1990; Ajala, 1990).

Semen consists of spermatozoa suspended in a fluid medium called seminal plasma. Seminal plasma is the fluid portion of semen, secreted by both the epididymis as well as the accessory glands before and during ejaculation. Seminal plasma is a complex fluid, which serves as a vehicle for transporting ejaculated spermatozoa towards their journey from the testes to their target, the oocyte. Seminal plasma not only transports the spermatozoa but also provides protection and nutrition to the spermatozoa during their onward movement in the female reproductive tract. Seminal plasma consists of various biochemical components, such as glucose, cholesterol, proteins, metabolites, intracellular and antioxidant enzymes, mineral elements which are important for sperm function and metabolism. In rabbit, the seminal plasma exhibits some positive roles, which include activation and augmentation of the sperm motility, buffering to provide the optimal osmotic and nutrient medium, prevention of premature activation during physiological transport of spermatozoa and stabilization of the plasma membrane with capacitation inhibitors, protection of spermatozoa from phagocytosis and destruction in an inflammatory environment. Addition of seminal plasma or its components into post thawed semen increases oxygen uptake and motility of spermatozoa (White *et al*, 1987). In the tropics the most restrictive constraint to effectual rabbit production is inefficient reproductive performance and Nworgu (2007) also reported that reproductive related problems especially infertility poses threat to rabbit production. Therefore for optimal productivity and profitability, as well as successful AI good reproductive performance of the buck is necessary. This study therefore sought to evaluate the effect of breed on the semen biochemical parameters of three breeds of adult rabbit bucks.

Materials and Methods

The study was carried out at the Rabbitary unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike. Umudike is situated in Ikwuano, Abia state in south eastern, Nigeria. Its geographical coordinates are 50' 28 North, 70' 33 East and at an altitude of 112m above sea level in the tropical rainforest zone Umudike has an average rainfall of about 2177mm per annum with a relative humidity of about 72% and a monthly temperature range of 22°C to 36°C (NRCRI, 2017).

Three different breeds of rabbit bucks were used for this study. A total number of thirty healthy domestic bucks (*Oryctolagus cuniculus*) were bought at 4 months old with average body weight of 1.90kg (New Zealand), 1.76kg (Dutch) and (1.75kg) Chinchilla. The animals were housed in their individual hutches. The animals were fed *ad libitum* with a commercial pelleted grower's ration alongside with forages such as *Centrosome pubescens, Calopogonium mucunoides and Panicum maximum.* Fresh and clean water was also made available for the animals.

The semen was collected from the rabbit bucks of different breeds with the aid of an improvised Artificial Vagina (AV) which was designed and constructed by Herbert and Adejumo (1995) shown in figure 1. The device was constructed using a PVC pipe reducer socket of about 4.2 cm and 5cm inner diameter and length, respectively. A round plastic valve was fitted into the center of the PVC socket to narrow down the canal. The device was equipped with two liners (inner and outer liners) both made of latex (condom) which were fitted inside the device. About 2 ml glycerol was poured inside the device (in-between the inner and outer liner), the liners were then fastened to the body of the device at the top and bottom with aid of elastic rubber bands. Before the semen collection, the device was pre-heated by immersing it in hot water about 60^{o}C for about 5 minutes. The function of the glycerol added to the device was to help retain heat (temperature) due to its anti-freezing property (cryo- protectant), thus keeping the device at the temperature that mimics the natural temperature of the female reproductive tract (vagina) so as to enhance ejaculation following intromission into the AV. A calibrated tube is attached to the device in other to measure the volume of the semen ejaculated

Semen samples were collected from different breeds of the rabbit bucks with the use of the artificial vagina were evaluated for Initial fructose (IF) (Mann 1984), total phospholipids (TPh) (Takayama *et al.* 1977), total cholesterol (TC) (Flegg 1973), total calcium (Tca) (Gindler and King 1972). Total protein (TP), albumin (Alb), total lipid (TL), the activities of aspartate aminotransferase (AST) and alanine aminotransferase (ALT), alkaline phosphatase (ALP), and globulin in semen were determined by colorimetric enzymatic methods using commercial kits purchased from bio-diagnostic company (Recycling Crusher-SBM R). (Attia *et al.,* 2009).

All data were tested for normality using Mann-Whitney's normality test, and were analyzed as a completely randomized design using One-way analysis of variance (ANOVA) coupled with appropriate post-hoc statistics. The statistical confidence was set at 95 % ($P < 0.05$). Values were expressed in terms of means ± standard error. The breed differences were investigated using multiple linear regression analysis (MLRA), in comparing the semen qualities, and the seminal biochemistry.

Results and Discussion

The result seminal plasma constituents of the three common breeds of rabbit bucks is presented in table 1. The findings from this study showed that there were significant (p<0.05) difference among the three breeds in the following biochemical parameters- total protein, initial fructose, total phospholipids, alanine amino transferase. There were no significant (p>0.05) different on the following biochemical parameters-Albumin, globulin, total cholesterol, total calcium, total lipids, Aspartate amino transferase and alkaline phosphatase. Chinchilla breeds of rabbit has the highest value in total protein (mg%), Globulin (g/DL), initial fructose (mg), total phospholipids(mg%) and total lipids (mg/DL). Dutch breed records the highest in total calcium (mg/DL) and new Zealand white breed has the highest value in albumin, total cholesterol (mg), aspartate amino transferase (AST), alanine aminotransferase(ALT), and alkaline aminotransferase (ALP). Chinchilla breed and New Zealand white breed recorded the highest value in different biochemical parameters.

The globulin level of Chinchilla, New Zealand White and Dutch rabbits were not significantly different (p>0.05). The values were within the normal value for rabbits although there is a decrease at the lower part of the reference range obtained among the three breeds. The decrease could have been as a result of endocrine malfunctions (Hansen *et al.*, 2008) and the differences indicates that New Zealand White breeds had the highest strength or ability to substitute it's feeds to fight against diseases when compared with Chinchilla breeds and Dutch breeds. The globulin value of were lower than the values obtained in several studies (Saad *et al*., 2016, Etim *et al*., 2011, The values of ALT (p>0.05) between the breeds showed no statistical significant (p>0.05) difference. The values found in the three breeds were within the normal reference range for rabbits and harmonized with values found in several studies (Simek *et al.*, 2017., Ngokere, 2014.,Talis, 2005., Ozegbe, 2005) which was an indication that the liver were not injured or damage. The ALT values of the three treatments were higher than the value obtained by Ahamefula *et al.* (2008) which could be a sign of necrosis and myocardic infarctions that may be indictors of poor protein of diets fed to the rabbits. B2 value was lower than value of Olayemi *et al.* (2007).

AST values was maximum in Dutch and Chinchilla while New Zealand white was the minimum although all the values falls within the reference range for rabbits and are similar with other studies (Ozcan, 2005., Ngokere, 2014., Talis, 2005.) which dictates that the cardiac and skeletal muscles were not damaged which could have resulted in the release of these enzymes into the blood thereby increasing their levels in the blood.

Table 1: Seminal plasma constituents of the three common breeds of Rabbit bucks

Semen biochemical Parameters	Breed		
	Dutch	**Chinchilla**	**New Zealand White**
Total protein (g/dl)	6.54 ± 0.0^{b}	6.86 ± 0.06^{a}	6.65 ± 0.10^{ab}
Albumin (g/dl)	3.38 ± 0.03	3.34 ± 0.01	3.41 ± 0.00
Globulin (g/dl)	3.29 ± 0.12	3.53 ± 0.00	3.30 ± 0.03
Initial fructose (mg %)	164.31 ± 0.50^{c}	172.03 ± 0.94^{a}	168.63 ± 0.36^{b}
Total cholesterol (mg %)	186.32 ± 1.07	187.69 ± 1.72	187.70 ± 3.41
Total phospholipids (mg %)	54.34 ± 0.60^{b}	57.16 ± 0.08^{a}	56.09 ± 0.26^{ab}
Total calcium (mg %)	6.85 ± 0.03	6.76 ± 0.09	6.72 ± 0.01
Total lipid (mg/l)	393.00 ± 2.64	395.33 ± 3.18	393.67 ± 0.88
AST (IU)	124.86 ± 0.14	120.76 ± 0.84	125.43 ± 2.39
ALT (IU)	29.10 ± 0.15^{a}	26.26 ± 0.50^{b}	29.90 ± 0.25^{a}
ALP (IU)	53.53 ± 0.74	52.30 ± 0.32	51.80 ± 0.81

Values were expressed as mean ± SEM. (n=6). 'a, b,c' indicates significant differences (p < 0.05) among the three breeds. Aminotransferase (AST), Alanine aminotransferase (ALT), Alkaline phosphatase (ALP).

Conclusion

Chinchilla breeds of rabbit has the highest value in total protein (mg%),Globulin (g/DL), initial fructose (mg), total phospholipids(mg%) and total lipids (mg/DL). Dutch breed records the highest in total calcium (mg/DL) and new Zealand white breed has the highest value in albumin, total cholesterol (mg), aspartate amino transferase (AST), alanine aminotransferase(ALT) and alkaline aminotransferase (ALP). Chinchilla breed and New Zealand white breed recorded the highest value in different biochemical parameters.

Recommendations

Based on the results of this study, it is recommended that Chinchilla breed and New Zealand white breed should be used in the production of genetically superior rabbit with good quality traits because increase in rabbit production is on a way of meeting the animal protein requirements of the Nigerian populace. Further studies should also be carried out on the semen biochemical parameters of other breeds of rabbit buck.

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Fig 1: Construction of artificial vagina

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Growth performance of quails *(Coturnix coturnix japonica)* fed varying levels of pro-vitamin A cassava root meal based diet

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Abstract
This study was conducted to evaluate the growth response of quails (Coturnix coturnix japonica) fed varying levels of pro-vitamin A cassava. Ninety-six Japanese quails were randomly allotted to four dietary treatments. In each of the four diets, sun-dried cassava tuber meal (SDCTM) was used to replace maize at 0, 25, 50, and 75% inclusion levels. The experimental design that was used is Complete Randomized Design (CRD). The study lasted for a period of 49 days (7 weeks). Feed intake was measured daily, and the quails were weighed once weekly. Feed and water were given ad-libitum. The parameters determined were Total feed intake, Average daily feed intake, Average daily weight gain, Total weight gain, Feed conversion ratio (FCR). Findings from the study showed that there was no significant difference (P>0.05) in feed intake among quails fed 0% (T_1), 25% (T_2), 50% (T_3) and 75% (T_4) levels of pro-vitamin A cassava root meal based diet. No significant difference (P>0.05) was observed in weight gain among T_1 (84.657±8.73), T_2 (79.247± 7.45), T_3 (89.800 ± 10.67) and T_4 (76.857 ± 10.36). The result of feed conversion ratio showed no significance difference among treatments group. It implies that SDCTM can favorably replace maize at any inclusion level though 50% level of inclusion had the best performance.
***Keywords**: Quails, Pro vitamin A cassava, Maize, Growth performance*

Introduction
The protein intake level of humans in most developing countries including Nigeria is very low due to the high cost of the product (Abeke *et al*., 2003). Animal protein is essential in human nutrition because of its biological significance and the poultry sub-sector is vital to its provision to the Nigerian populace. The poultry industry in Nigeria has hitherto been dominated by rearing of domestic chickens. However, in recent times there have been new entrants into the sector. One of the poultry species slowly gaining prominence is the Japanese quail (*Cortunix coturnix japonica*) which is suited for commercial rearing, meat and egg production under intensive management (Egbeyale *et al.,* 2013). Quails have a lower feed requirement compared to the chicken, also require minimal space for rearing (Ijaiya *et al.,* 2013). They thrive well in small cages and can be reared at a cheaper cost within a relative short time (Ojo *et al.,* 2011). Hemid *et al*. (2010) reported that quails have a short generation interval, high rate of lay and much lower feed and space requirements than the domestic fowl. Quail eggs are very rich in vitamin D, antioxidants which according to Sahin *et al*. (2008) improve the quality of food from animal origin in terms of colour, oxidative stability, tenderness and storage properties. They have a highly positive effect on people with stress problems, hypertension, digestive disturbance, gastric ulcer, liver problems, bronchitis illness, depression, panic and anxiety illness. The nutritional value of quail eggs is 3–4 times greater than the nutritional value of chicken eggs (Tunsaringkarn *et al.,* 2013). Quail eggs are also known to increase sexual appetite, stimulate brain functions which improve intelligence quotient and generally rejuvenate the body (Onyewuchi *et al.,* 2013). There are also some claims that consumption of quail eggs fortifies the woman's body during pre- and postnatal periods as well as

after surgery and radiotherapy (Onyewuchi *et al.,* 2013). Quail meat is tastier than chicken and has less fat content (Igado and Aina, 2010). Generally, products from quail birds are known for their high quality protein, high biological value and low caloric content, making it a choice product for a hypertensive patient (Sahin *et al*., 2008).

The increasing competition between man and livestock for available grains and tubers for food, feed and industrial raw materials coupled with Nigeria's sole concentration on oil sector to the utter neglect of agriculture, has further led to the high cost of available food/feed resources (Udedibie and Durunna, 2000). Poultry feed producers are thus faced with the task of finding alternative feedstuffs that will not compromise quality. The search of such alternatives has occupied the attention of Animal Nutritionists in Nigeria for over a decade (Onyimonyi and Okeke, 2002; Onyimonyi and Onukwufor, 2003; Oke *et al*., 2005; Onyimonyi and Okeke, 2005; Tuleun *et al*., 2005). Cassava appears to possess the potential of serving as an alternative to maize. This study therefore assessed the growth performance of quails (*Coturnix coturnix japonica*) fed varying levels of pro-vitamin A cassava.

Materials and methods

The study was carried out at the Teaching and research poultry unit of the Department of Animal Science and Technology, Faculty of Agriculture, Nnamdi Azikiwe University, Awka, Anambra state. The location lies between latitude 6.24^0N & 6.28^0N and longitude 7.00^0E and 7.08^0E on the south eastern part of Nigeria (Ezenwaji *et al,* 2013).

Fresh pro vitamin A cassava was sourced from a reputable farm. The roots were washed and chopped into small pieces using kitchen knife, the roots were sun-dried on a tarpaulin sheet for about five (5) days with regular turning. Sun-drying is aimed at reducing the moisture content. The chopped root was milled using a hammer mill and used to compound the experimental diet.

A total of Ninety-six (96) day old unsexed Japanese quails (*Coturnix coturnix japonica*) were purchased from a reputable farm. These quails were weighed individually and randomly allocated into four (4) dietary treatment group of T_1 (0% Pro vitamin A cassava), T_2(25% Pro vitamin A cassava), T_3 (50% Pro vitamin A cassava) and T_4 (75% Pro vitamin A cassava). Each treatment was assigned twenty-four quails which has three replicate of eight quails per replicate. The experimental design that was used is Complete Randomized Design (CRD). Before the arrival of the birds, the brooder pens, feeding and drinking troughs were cleaned and properly disinfected. Litter materials (wood shavings) were spread on the floor to absorb moisture and ease the regular removal of poultry droppings from the house. The feeding and drinking troughs were put in their positions on the litter. Feed and water were given to the birds *ad libitum*. Adequate care was taken to prevent the chick from drowning in water troughs by placing stones in their drinkers. Light was provided for 24hrs during brooding to avoid cold and mortality. The gross composition of the experimental diet, proximate analysis of the test ingredient and proximate analysis of the experimental diets is shown in Table 1, 2 and 3 respectively.

The parameters determined were Total feed intake, Average daily feed intake, Average daily weight gain, Total weight gain, Feed conversion ratio (FCR). The data was subjected to ANOVA (Analysis of Variance) as described by Obi (2002) using SPSS package (2003). Means were separated using Duncan New Multiple Range Test (Duncan, 1955).

Table 1: Gross Composition of the Pro Vitamin A Cassava Root meal Based Diet

Ingredient (%)	T_1 (0)	T_2 (25)	T_3 (50)	T_4 (75)
Maize	50.00	37.50	25.00	12.50
Cassava root meal	0.00	12.50	25.00	37.50
Soya bean meal	25.00	25.00	25.00	25.00
Groundnut cake	6.00	6.00	6.00	6.00
Palm kernel meal	5.00	5.00	5.00	5.00
Wheat offal	5.00	5.00	5.00	5.00
Fishmeal	3.00	3.00	3.00	3.00
Palm oil	2.00	2.00	2.00	2.00
Bone meal	3.00	3.00	3.00	3.00
Salt	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Vit/Min Premix	0.25	0.25	0.25	0.25
Total	100	100	100	100

Table 2: Proximate analysis of Pro Vitamin A Cassava Root Meal

Nutrient	Composition (%)
Dry matter	88.15
Moisture	11.85
Ash	1.20
Crude protein	4.38
Ether Extract	0.15
Crude fibre	4.75
Nitrogen free Extract	77.67
Metabolizable energy	3286.64

Table 3: Proximate Analysis of the Experimental Diets

Parameter	Dry Matter (%)	Crude Protein (%)	Ash (%)	Crude Fat (%)	Crude Fibre (%)	Nitrogen Free Extract
T1 (0%)	90.10	19.18	3.06	4.03	3.38	70.35
T2 (25%)	90.05	20.71	3.88	7.97	4.75	62.69
T3 (50%)	89.46	19.28	3.57	6.43	5.74	64.98
T4 (75%)	89.30	19.10	3.27	6.13	5.82	65.60

Results and Discussion

The growth performance of Japanese quail (*Cortunix coturnix japonica*) fed varying Levels of Pro Vitamin A Cassava is presented in table 4. The result of this study showed that there was no significant ($P>0.05$) difference in the feed intake amongst treatments. This is in agreement with the findings of Odo and Nnadi (2012). The no significant difference amongst treatment could be due to relatively similar chemical composition of the experimental diets. The study recorded the highest feed intake in T_3(1678±251) and the least feed intake in T_4(1560±184), this result is in agreement with Hagerman (2002) that presence of anti-nutritional factors in higher quantity in diets reduces palatability of the diet and thus feed intake of livestock.

There was no significant ($P>0.05$) difference in the weight gain amongst treatment group. This could be due to the relatively similar crude protein (isonitrogenous) of the four diets. Olubamiwa *et al*. (2009) also stated that growing quails are able to keep body growth rate over a wide range of dietary energy levels. The report of this study is also in agreement with the findings of Odo and Nnadi (2014). The highest weight gain was recorded in T_3 (89.00±10) whereas the least weight gain was recorded in T_4 (76.88±10), this could be due to presence of higher level of anti-nutritional factors present in T_4, This is in agreement with the findings of (Akande *et al.,* 2010), who opined that in poultry, negative effects such as feed intake reduction, poor nutrient utilization, and growth depression have been attributed to the presence of anti-nutritional factors in diets constituting non-conventional feedstuffs

The result of this study showed that there was no significant ($P<0.05$) difference in the feed conversion ratio amongst treatment, however, T_3(3.04±0.26) had the best feed conversion ratio, whereas T_2(3.38 ± 0.56) had the least conversion ratio, this could be due to the relatively higher crude fibre content of the T_3 diet compared with the T_2 diet. The findings of this report is in agreement with the findings of Odu and Nnadi (2014) but disagrees with the findings of Whyte *et al.* (2000) who observed that feed conversion ratio (FCR) varied significantly ($P<0.05$) among the different treatment groups. It was highest in T_4 group with 75% inclusion level of cassava tuber meal followed by T_3, then T_2 and lowest in T_1 with zero percent inclusion level of cassava tuber meal as a replacement for maize

Conclusion and Recommendation

It can be concluded that Pro vitamin A cassava can be used to replace maize by 25%, 50% and 75% because there was no significant difference among them. Although, the best level of inclusion of cassava tuber meal as a replacement for maize is 50% since the quails achieved their highest feed intake and weight gain at this level.

In view of the high cost of maize and the uncertainty about their sustainable supply as energy source for livestock and poultry, I recommend that cassava tuber meal can be used as a replacement for maize at 50% level in quail diet. This will obviously improve productivity of quails.

Table 4: Growth Performance of Japanese quail (*Cortunix coturnix japonica*) fed varying Levels of Pro Vitamin A Cassava

Parameter	T_1	T_2	T_3	T_4
Average daily feed intake per bird(g)	33.1718 ± .239	33.1071 ±2.192	34.2491± 6.366	31.8384 ± 5.1278
Total body weight gain (g)	84.657 ± 8.73	79.247± 7.45	89.800 ± 10.67	76.857 ± 10.36
Total Feed Intake(g)	1625.42 ± 11.69	1622.25 ± 107.41	1678.21 ± 251.26	1560.08 ± 182.22
Feed efficiency(g)	0.65 ± 0.064	0.61 ± 0.093	0.68 ± 0.060	0.622 ± 0.093
FCR	3.16±0.31	3.38 ± 0.56	3.04 ± 0.26	3.33 ± 0.49
Daily weight gain	1.728±0.178	1.617±0.1520	1.833±0.218	1.5685±0.211

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Comparative evaluation of the effect of breed on the semen quality of rabbit

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Abstract

This study was carried out to determine the effect of breed on the semen quality of 3 breeds of rabbits namely New Zealand white (NZW), Dutch (DUTCH), and Chinchilla (CHINCH). A total of 30 rabbit bucks (10/breed) were assigned into 3 treatments with 10 replicates each in a Complete Randomized Design. The animals were fed ad libitum with a commercial growers pellet containing 16% crude protein alongside with forages. Fresh water was made available. The rabbit bucks were trained for semen collection for 2 weeks with artificial vagina using a female doe as a teaser. After adaptation period semen was collected using artificial vagina. Reaction time and semen characteristics were studied during the experiment. The results showed that the reaction time was fastest in CHINCH followed by NZW and DUTCH. Nevertheless, semen pH was highest in DUTCH. Sperm concentration and live sperm proportion were highest in CHINCH breed. Discrepancies were observed in semen pH, semen consistency, sperm mass motility, proportion of live sperm, total viable spermatozoa, and total abnormal Spermatozoa among different breeds. However, no significant effect of breed was recorded on semen volume, semen color, total number of ejaculate, normal spermatozoa proportion. At the end of the study it was found that the CHINCH breed had the highest semen quality going by semen motility, livability, semen concentration and morphology values of 85.25%, 93.53%, 114.05×10^6/ml and 98.17%, respectively. A further research is recommended on the effect of other factors on the semen quality of rabbit bucks.

Keywords: Chinchilla, New Zealand White, Dutch, Semen evaluation, Semen characteristics, Artificial vagina

Introduction

Rabbit (*Oryctolagus cuniculus*) is a micro livestock species and is one of the cheapest and fastest means of producing high quality animal protein and fast-growing livestock. According to Ajala and Balogun (2004) rabbits possess a number of qualities that will be of advantage in the small holder farming subsistence integrated farming in Nigeria and its production is an appropriate means of eradicating low animal protein intake in Nigeria. Onifade *et al*. (1999) as cited in Shinkut (2015) reported that rabbit meat is rated sixth in the order of meat animal production and consumption in Nigeria. Other studies have reported that rabbit is highly adaptable to the tropical environment, very easy to control and manage, high growth performance, high food conversion ratio, short gestation period and very high prolificacy and buck attains sexual maturity as early as 5 months depending on the breed. Also Omole *et al*. (2005) posited that the rabbit meat is a white meat and has high quality because it contains high level of protein, low sodium, fat and cholesterol. It's used for educational and research purposes and as pets and its faeces is a good source of manure, and there is no religious or cultural barrier against its consumption. The rabbit is a pseudoruminant and are hindgut fermenters which enables it to digest large amounts of fibrous feed as most non ruminant species cannot and they also practice coprophagy. Costs of other conventional sources of meat such as cattle, sheep ,goat, and poultry are high compared to rabbit meat .Rabbit farming in Nigeria is faced with many constraints, which has led to the massive decrease of supply of meat to meet up the demands of the growing populace. (Nworgu, 2007).

The quantity and quality of semen determines the ability of the semen to fertilize as well as its viability. Many factors have been associated with the quantity and quality of semen output and normal morphology is considered as one of the most important. The quality of semen in relation to its fertilizing capability is determined by the morphological features of spermatozoa, percentage of live spermatozoa concentration, motility of spermatozoa and the ejaculated volume also the length and breadth of sperm cell add to the quality of the sperm with respects to its fertility. (Akhter *et al*., 2013).

The evaluation of the reproductive capacity of the buck should be regarded as an advantageous practice among breeders because the semen quality characteristics represents the reproductive potential of the male and the functionality of the testicles. All the methods used for the verification of semen quality that are widely known are valued for the symptoms of the essential processes of the spermatozoa, morphological characteristics and chemical composition. According to Lavara *et al* (2005) information regarding the fertilizing ability of sperm must be revealed by evaluating the semen. In spite of the fact that the use of one feature does not provide as much as is needed exactly to prejudge the fertility of the semen ,the number of spermatozoa inseminated and their motility are the most pertinent parameters that are associated with the rate of fertility . Additionally, the intricacy of semen evaluation is such that consequential variability among laboratories can be introduced in the evaluation of sperm parameters (sperm counts, motility and morphology; WHO, 1999).

Quinteiro *et al*. (2007) produced a composite index which better prejudge the fertility and fecundity of semen samples by inserting several characteristics of rabbit semen (motility, sperm abnormalities and altered acrosomes). Nonetheless, seminal characteristics is known to be affected by many factors (genetic strain, feeding, health status, rearing condition, season, age and collection frequency), which consequently contributes to the significant variability in semen traits (El-Azim and El-Kamash, 2011).

Previous studies have found that Semen evaluation is imperative in AI programs, because the quality and concentration of spermatozoa determines the extent to which the semen will be diluted, hence the number of females which can be inseminated .The success of an AI program also depends on the assessment of the potential fertilizing capacity of the spermatozoa in the semen. In the tropics the most restrictive constraint to effectual rabbit production is inefficient reproductive performance and Nworgu (2007) also reported that reproductive related problems especially infertility poses threat to rabbit production. Therefore for optimal productivity and profitability, as well as successful AI good reproductive performance of the buck is necessary. This study therefore sought to compare the semen characteristics of New Zealand, Dutch and Chinchilla breeds of rabbits.

Materials and Methods

The experiment was carried out at the Rabbitry Unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike. Umudike is situated in Ikwuano, Abia State in South Eastern Nigeria in the west of Africa. Its geographical coordinates are 50 28' North, 70 33' East and at an altitude of 112m above sea level in the tropical rainforest zone. Umudike has an average rainfall of about 2177mm per annum with relative humidity of about 72% and a monthly temperature range of 22^{o}c to 360^{o}c (Meteorological station of National Root Crop Research Institute (NRCRI), Umudike)

A total of 30 rabbit bucks (10/breed) were used. Care was taken when placing the animals into groups according to their different breeds' .The animals were about 4 months old and the experiment lasted for 8 weeks. The bucks used for the experiment had average body weight of 1.76, 1.90, 1.75 KG for Dutch, NZW, CHINCH breeds respectively. The animals were housed in their individual hutches. The animals were fed *ad libitum* with a commercial pelleted grower's ration alongside with forages such as *Centrosema pubescens, Calopogonium mucunoides* and *Panicum maximum*. During acclimitization period anti- stress, antibiotic and anthelmintic were administered which lasted for 2 weeks. The animals were prophylactically treated against ecto and endo parasites by administering 0.2ml Ivomectin per rabbit subcutaneously. They were equally

given broad spectrum antibiotic 0.4ml intramuscularly. Fresh and clean water was also made available for the animals. The feeders, water troughs and surroundings were always kept clean.
The semen was collected from the rabbit bucks of different breeds with the aid of an improvised Artificial Vagina (AV) which was designed and constructed by Herbert and Adejumo (1995). The animals were trained for two weeks with artificial vagina using a female as teaser. The semen colour and consistency was evaluated macroscopically and recorded. The consistency scale (1-4), adopted by Chibundu (2013) was used. **Consistency score 1:** Whey-watery, **2:** Watery, **3:** Thick, and **4:** Very thick

Colour score: **1:** Milky-white, and **2:** Creamy-white

Semen ejaculates were collected using an artificial vagina maintained at 45.8^{0}C to 46.8^{0}C and a teaser doe. The volume of each ejaculate was recorded after removal of the gel mass. The reaction time (RT) was the time interval from the introduction of the teaser doe into the male's cage to ejaculation; it was measured in seconds using a stopwatch and was considered as an indication of libido. Immediately after collection, semen was maintained at 35.8 in a water bath for evaluation. Fresh semen (two drops) was placed on a warm slide and covered with a cover slip to determine mass motility. Mass motility from at least three fields was examined at 37.8^{0}C under a microscope with phase-contrast optics, at × 40 magnification, and assessed from 0% to 100%. The total sperm output was calculated by multiplying semen ejaculate volume and semen concentration. Assessment of live and abnormal spermatozoa was performed using an eosin–nigrosin blue-staining mixture (El- Sherbiny, 1987 modified by Attia *et al.,* 2009). The percentage of live, dead and abnormal spermatozoa was determined using stains that penetrated cells with damaged membranes. Normal live sperm exclude the eosin stain and appear white in color, whereas dead sperm take up eosin and appear pinkish in color because of loss of membrane integrity. Normal sperm have an oval head with a long tail. The total number of motile sperm was calculated by multiplying the percentage of motile sperm and the total sperm outputs. The total viable sperm (TVS) or functional sperm fraction (TFSF) was also calculated by multiplying the total sperm output and sperm motility and normal-morphology sperm (Correa and Zavos, 1996).
The method described by El- Sherbiny (1987) was adopted. The semen samples collected via epididymal washings from each treatment group was evaluated for progressive motile sperm cells. This was done immediately after collection. A drop of the semen was smeared on a preheated glass slide and viewed under a light microscope at a lower magnification of 10 and 40 and scored subjectively in percentage. The Descriptive and numerical scales for evaluation of microscopic pattern of semen is shown in table 1.

Table 1: Descriptive and numerical scales for evaluation of microscopic pattern of semen.

Numerical scale	Descriptive scale	% sperm motility	Wave pattern
0	V. Poor	0 – 20	Immotile, no wave
1	Poor	20 – 40	Stationary and bunting. Weak movements; no waves
2	Fair	40 – 50	Oscillatory or rotary movements. Few waves and eddies
3	Good	50 – 80	Progressive rapid movement. Waves and eddies seen.
4	V. good	80 – 90	Vigorous rapid movement. Eddies seen
5	Excellent	90 - 100	Very vigorous rapid movement. Rapid waves and eddies

Source: Peter (2002).

Individual motility score (1 – 4), **Progressive rectilinear motility –** rapid straight forward movement, **Circling motility –** moves in circles because of mid and tail defects, **Reverse circling motility –** moves in circles, in backward direction; no marked progress., **Pendulation motility –** jerky, serpentine movement; no marked progress

The proportion of sperm cells that are viable (alive) was determined by staining a drop of the collected semen (epididymal washings) with Eosin-Nigrosin stain. The stained glass slides were allowed to dry for 30 seconds before fixing with ethanol. The stained slides were viewed under a light microscope at 100 magnification (oil immersion), and the proportion of the sperm cells that were viable was counted with a hand-held stopwatch manual counter. A total of 300 cells were counted and the percent viable sperm cells calculated. The sperm cells that were alive (viable) did not pick the stain while those that picked the stain were dead (El-Sherbiny, 1987).

The concentration of the sperm cells in the semen samples were evaluated using the haemocytometer, a method described by Herbert (1992). A dilution of 1: 200 was made using a red blood cell pipette. 10% buffered formalin solution was used as the semen diluting fluid to immobilize the sperm cells. The **haemocytometer** was charged with a drop of the sperm solution and allowed for 2 minutes on a wet paper (to allow the sperm cell to settle) before it was mounted on a light microscopic stage and viewed under 40 magnification. The abnormal sperm proportion was determined by the method described by El- Sherbiny (1987). A drop of the semen was stained using E/N stain and the mixture smeared on a glass slide and viewed under a lower magnification of × 40 to check for primary and secondary abnormal sperm cells, percentage of the differential abnormalities such as head abnormalities, tail abnormalities, mid-piece abnormalities etc. (El-Sherbiny, 1987).

All data were tested for normality using Mann-Whitney's normality test, and were analyzed as a randomized design using One-way analysis of variance (ANOVA) coupled with appropriate post-hoc statistics. The statistical confidence was set at 95 % ($P < 0.05$). Values were expressed in terms of means ± standard error. The breed differences were investigated using multiple linear regression analysis (MLRA), in comparing the semen qualities.

Results and Discussion

The results of the semen qualities of the three common indigenous breeds of rabbit bucks is presented in table 2. There were no significant ($p>0.05$) differences on the reaction time/sec, semen volume, semen colour, individual sperm motility, total number of spermatozoa and normal spermatozoa proportion of the different rabbits. However there were significant ($p<0.05$) differences between the breeds on semen pH, semen consistency, sperm mass motility, proportion of live sperm, sperm concentration, total viable spermatozoa and total abnormal spermatozoa.

The results indicated that there was no significant ($p>0.05$) difference between the breeds on reaction time where the value of Dutch was 2.27, NZW 2.67 and CHINCH 2.28. Although there are no standard values for reaction time in literature but previous research has found out that the shorter the reaction time, the higher the libido, while the longer the reaction time the lower the libido. The findings of the study shows that the reaction time is short and it implies high libido which in turn indicates that the animal is sexually mature.

The outcome of the study on the effect of breed on semen volume shows that they are statistically the same at $p<0.05$ where the value of Dutch was 0.55ml, NZW 0.50ml and CHINCH 0.61ml this result is agreement with that of Brackett (2004) who reported that semen volume varies from 0.4 - 0.6. The result is also close to that of IRRG (2005) who reported that semen volume varies with 0.3 - 0.9ml. According to previous research a large volume of semen does not imply that the total spermatozoa content is greater than those from large nevertheless large volume is not preferable because the larger the volume the lesser the concentration.

The semen pH of Dutch (7.56) was higher than that of NZW (7.46) and CHINCH (7.51) the measurement of semen is of great importance because any semen extender used should be approximated to the same pH as the semen. (El-Azim and El-kamash, 2011). This results is in agreement with the literature findings of Alvarino (2000) who asserted that semen pH varies between 6.8 - 7.3 and with that of El-Azim and El-kamash (2011) they reported that the semen volume to be between 7.35 - 7.50. This result is far from that of WHO (1999) whose result is 6.8 - 8.4. Semen pH should be slightly alkaline and if it is not so this indicates a bad semen quality. The result of the semen pH shows that the semen is slightly alkaline and thus its of good quality.

Semen colour was graded from milky white to creamy white. All the breeds had the same colour of semen which is milky white. The effect of breed is not significant in this regard this shows that at $P>0.05$ the results are statistically the same. The Results were close to with those of Arrebola and Fernandez (2011) who is of the view that pearly white semen is of good quality and it agrees with those of Campos *et al*. (2014), Alvarez *et al.* (2006) and Gorge *et al*. (2017) they all posited that semen of good quality should have a milky appearance as this gives an indication of high semen concentration. This result is far from that of Matavelli (2008) who opined that the best quality semen is found in creamy - white semen. The result of the semen color of the rabbit shows that it was not contaminated during collection, because yellowish semen according to Campos *et al.* (2014) is as a result of contamination with which occurs when the temperature of the artificial

vagina is too high. The semen color obtained from this study shows that semen is normal and of good quality and this could also be attributed to the healthy state of the animal too.
The effect of breed was highly significant on Semen consistency which means that values are statistically different at $p<0.05$, the values obtained were 2.00, 2.66, and 2.66 for Dutch, NZW and CHINCH breeds respectively. The consistency was graded from whey-watery, watery, thick to very thick. The result of the study found out that the consistency of Dutch breed was whey-watery while those of NZW and CHINCH were watery.

There were no significant difference in the individual sperm motility of the 3 breeds they are statistically the same at $p>0.05$. The individual sperm was graded from progressive rectilinear motility, circling motility, reverse circling motility and pendulation motility. The result of the study found out that the individual sperm motility of the 3 breeds were in a progressive rectilinear motility. The mass motility of semen was significantly different between the 3 breeds at $p > 0.05$, the CHINCH breed had the highest sperm motility of 85.25% while Dutch and NZW had 78.33% and 80.00% respectively. The findings of this result is in agreement with those of Brackett (2004), Salcedo-Baca *et al.* (2004), IRRG (2005), Ogbuewu *et al.* (2009) and Iwuji and Herbert (2012). They all posited that semen of good quality should have a motility range of 30-90%. This is important because it is believed to be the most pertinent parameter related to male fertility because of its relevance for spermatozoa migration through the genital tract and for gamete interaction at fertilization. It also portrays the viability and vigour with which the sperm cells are propelled during the process of fertilization. Low motility denotes bad semen quality and poor reproductive performance of the animal thus reducing its fertilizing capacity. The result of the study implies that the animals are reproductively sound.

Results for live sperm (%) indicated that NZW had the lowest value (84.33%) compared with Dutch (91.80%) and CHINCH (93.53%) the effect of the breed was significant in this parameter showing that the values are statistically different at $p<0.05$, with CHINCH breed having the highest result of 93.53%. This result is in agreement with those of Brun *et al.* (2002b) who graded sperm cells with more than 70-80% viability as very good and Uysal *et al.* (2010) who is of the view that rabbit semen of good quality should not possess more than 25% of dead cells. The result for total viable spermatozoa is highest in CHINCH breed (598.04) compared to those of Dutch (458.720) and NZW (392.25) and the effect of breed is highly significant in this parameter.

The result for sperm cell concentration was highest in chinch breeds ($114.05 \text{x} 10^6$ml) while that of Dutch and NZW were 107.55×10^6/ml and 102.74×10^6/ml respectively. The effect of breed was significant implying that they are statistically different at $p<0.05$ with CHINCH breed having the highest sperm cell concentration. This result does not agree with those of IRRG (2005) and El-Azim and El-Kamash (2011) they reported that the concentration of rabbit semen varies between 150-$500 \text{x} 10^6$sperm/ml but agrees with that of farrell *et al*.(1993)they asserted that the minimum sperm numbers required for fertility were 0.05million and 0.1million for normal litter size. The result is also far from that of Ogbuewu *et al*. (2009) who reported the value of 20.15×10^6/ml. This could have been caused by the feeding protocols of ogbuewu *et al*.(2009).Also the total number of spermatozoa/ejaculate is 60.04, 51.54 and 70.87 for Dutch, NZW and CHINCH breeds respectively .There is no significant difference on the effect of breed on this parameter ,they are statistically the same at $p>0.05$. The result is far from that of Ogbuewu *et al. (*2009) who reported a value of 14.75×10^6/ml for total sperm ejaculate. The reason for low concentration in this result could be due to lack of necessary sexual stimulation and age too. The bucks should be sexually stimulated before copulation because it increases the concentration semen thus enhancing the fertilizing capacity of the semen this is important because insemination with too low number of viable spermatozoa results in reduced pregnancy rate or no pregnancy at all.

The results indicated that the effect of breed on normal spermatozoa proportion was not highly significant ($p>0.05$) indicating that they are statistically the same where the value of Dutch was 98-05%, NZW 96.95% and CHINCH 98.17%. The result is close to those of Salcedo-Baca *et al.* (2004) who reported the following values for NZW and CHINCH breeds to be 94.69% and 94.18% respectively. This shows that the sperm was morphologically sound and as such has high fertilizing capacity. Also results from total abnormal spermatozoa shows that the effect of breed was highly significant at $p<0.05$, where the value of Dutch was (1.94), NZW (4.54) and CHINCH (1.82). The results are in agreement with those of Kuzminsky (1999) who is of the view that total abnormal sperm should not exceed 17-18% and that of Brackett (2004) who indicated that every ejaculate contains some abnormal spermatozoa but when it is more than 20% it leads to reduction in fertility while an expected range of 8-10% has no adverse effect on fertility. The final result of the study is in agreement with that of Oyeyemi *et al*. (2007) who is of the view that fertility capacity or semen quality is increased with the increasing percent of motility, livability, semen concentration without increasing in abnormal sperm cells. This implies that CHINCH breed has the lowest number of abnormal sperm cells this could be attributed to the genetic makeup of this breed thus showing that it is genetically sound.

Conclusion

The result of the findings shows that the effect of breed was not significant on the following parameters Reaction time, semen volume, semen colour, normal spermatozoa, Total number of spermatozoa and Individual sperm motility. The result also shows that the effect of breed was significant on the following parameters semen pH, semen consistency, sperm mass motility, sperm concentration, total viable spermatozoa, total abnormal spermatozoa, proportion of live sperm. The result of the study shows that the chinchilla breed of rabbit had the highest motility, livability, semen concentration and morphology and this implies that it has the highest semen quality. Semen motility and semen morphology are very important parameters correlated to male fertility as they are useful tools used for detection of sperm fertility and estimation of semen quality. Adequate morphological screening allows elimination of animals with low fertility potential and low semen quality.

Table 2: Semen qualities of the three common indigenous breeds of Rabbit bucks in Nigeria.

Semen Parameters	Breed		
	Dutch	**New Zealand White**	**Chinchilla**
Animal Weight (kg)	1.76 ± 0.05^{ab}	1.90 ± 0.03^{a}	1.75 ± 0.04^{b}
Reaction time/sec (libido)	2.27 ± 0.12	2.67 ± 0.15	2.28 ± 0.11
Semen volume (ml)	0.55 ± 0.06	0.50 ± 0.03	0.61 ± 0.07
Semen pH (1 – 14)	7.56 ± 0.02^{a}	7.46 ± 0.01^{b}	7.51 ± 0.01^{ab}
Semen colour (1 – 2)	1.00 ± 0.00	1.33 ± 0.21	1.00 ± 0.00
Semen consistency (1 – 4)	2.00 ± 0.00^{b}	2.66 ± 0.21^{a}	2.66 ± 0.21^{a}
Individual sperm motility (1 – 4)	1.00 ± 0.00	1.00 ± 0.00	1.00 ± 0.00
Sperm mass motility (%)	78.33 ± 2.69^{b}	80.00 ± 0.57^{ab}	85.25 ± 1.54^{a}
Spermatozoa live proportion (%)	91.80 ± 1.61^{a}	84.33 ± 1.47^{b}	93.53 ± 1.32^{a}
Sperm concentration (10^6/ml)	107.55 ± 3.24^{ab}	102.74 ± 2.19^{b}	114.05 ± 2.30^{a}
Total number of spermatozoa/ ejaculate (10^6/ml)	60.04 ± 8.53	51.54 ± 4.31	70.87 ± 9.04
Total viable spermatozoa (10^9/ml)	$458.72+ 21.04^{ab}$	392.25 ± 20.49^{b}	598.04 ± 24.12^{a}
Normal spermatozoa proportion (%)	98.05 ± 0.27	96.95 ± 0.63	98.17 ± 0.28
Total abnormal spermatozoa (%)	1.94 ± 0.27^{b}	4.54 ± 1.24^{a}	1.82 ± 0.28^{b}

*Means bearing the different superscripts along the same row are significantly different ($p<0.05$)

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Performance and economic evaluation of giant African land snails *(Archachatina marginata)* fed different levels of whole jack fruit meal

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Abstract
This study was carried out to investigate the growth performance and economic evaluation of Giant African Land Snail (Archachatina marginata) fed whole jackfruit based diet. A total of 120 Giant African Land Snails (Archachatina marginata) were used. The study was carried out at the Snailery unit of Teaching and Research farm of Animal Science Department, Nnamdi Azikiwe University, Awka. The snails were randomly grouped into four treatment and replicated thrice with ten snails in per replicate. The jackfruit was sourced from Igbo-Ukwu in Aguata local government area of Anambra state. The whole jackfruit was cut into pieces and then oven dried and finely ground. The jackfruit meal was incorporated into the diets at the rate of 0, 5, 10, and 15% as T_1, T_2, T_3, and T_4 dietary treatments respectively with each treatment having thirty snails. The experiment lasted for 8 weeks including the one week acclimatization period. At the end of the experiment the growth performance parameters were evaluated. There was significant difference ($P<0.05$) in weight gain between the treatment group. Snails fed T_4 gave a higher weight gain and had a highest feed intake. T_4 also gave a better feed conversion ratio. In the area of shell length increment there was no significant difference ($P>0.05$). This was also observed on the shell thickness having a higher increment value with no significant difference with the other treatments. There was no significant difference ($P>0.05$) observed for the shell girth increment but T_2 gave a higher numerical value. Likewise, no significant difference ($P>0.05$) was observed for the shell aperture. This study also showed an improved cost effectiveness on the snails under T_4 as it gave better value on the feed cost (#) per weight gain and had the best feed conversion ratio than others and there was a significant ($P<0.05$) difference between the treatment diets on the cost effectiveness. Thus it could be recommended to farmers and feed millers to incorporate whole Jackfruit meal in the diet of snails.

Keywords*: Archachatina marginata, Whole jackfruit meal, Shell girth, Shell aperture, Shell length*

Introduction
Nigeria is endowed with abundant food and had a climate that supports various species of wildlife, domestic animals and crops; yet more than 70% of the population are hungry with a mean daily protein consumption of about 30g below the recommended dose per person. Snail coupled with other small livestock species such as grasscutter, giant rat constitutes ''micro-livestock'', a new but rapidly expanding area of animal production and research. The snail forms a common component of food in the diet of people, rich in protein (88.37%) thus compares well with conventional animal protein sources, beef (92.75%), broiler (92.21%), chevron (86.63%), mutton (86.34%), pork (82.42%) and fish (91.99% and 90.81%) (Banjoko, 2010). Snail belongs to a group of invertebrate called Mollusc (Akinyemi, 2008). The *Archachatina marginata* is the most accepted and highly cherished snail specie in Nigeria. Snails having a considerable quantity of protein will help to a great dimension in giving a boost to the animal protein intake by Nigerians as reported by FAO (2007) that Nigerians consume only 5.5g per head per day far below the recommended 35g. The African giant land snails are regarded as delicacies and important source of animal protein. In many developing countries meat production from domestic livestock is not sufficient to meet the

high demands for animal protein. Revitalization of some wild animal species like snail could assist in combating this challenge (Ademola *et al*. 2004). It is highly nutritious and contains 19.53g of protein/100g of fresh meat, has low fat content of 2.44% and rich in calcium (126.4mg/100g) and iron (2.29mg/g) (Babalola *et al*., 2015). The low fat content of snail meat makes it a good antidote for fat related diseases such as hypertension, atherosclerosis, e.t.c and is readily accepted by many people.

One of the major challenges in snail production is the feeding aspect especially due to the cost of feed materials. In livestock farming, feed cost is responsible for 60-70% of the total cost of production (Omole *et al,* 2010). Against this back drop the need to utilize the whole jackfruit powder meal as a component for feed to the snail which will hopefully not only make it economical in the feeding of snail but also will help increase the weight gain of the giant African land snail (*Archachatina marginata*).

Materials and Methods

The study was carried out at the Snailery unit of Teaching and Research farms of the Department of Animal Science and Technology, Faculty of Agriculture, Nnamdi Azikiwe University, Awka, Anambra state. The location lies between Latitude 6.24^{0}N and 6.28^{0}N and longitude 7.00^{0}E and 7.08^{0}E on the South Eastern part of Nigeria, the climate is the tropical wet and dry type with a clear season, the mean daily maximum temperature is usually 27^{0}C all over the year although it could reach 34^{0}C in March and lowest during the harmattan months of December and January (Ezenwaji *et al,* 2013).

A total of one hundred and twenty *Archachatina marginata* were procured from a reliable source and transported to the study area in a well aerated polyethylene bags. The snails were fed with vegetables for the one week acclimatization period. After acclimatization, the snails were randomly assigned into different bowls according to the levels of whole jackfruit meal inclusion that is T_1, T_2, T_3 and T_4. T_1 which served as control did not contain whole jackfruit meal while T_1, T_3 and T_4 contained 5%, 10% and 15% whole jackfruit meal respectively. Each of the treatment was replicated three times in Complete Randomized Design. Ten (10) snails were randomly placed into the twelve bowls which had the dimension 15cm depth and a diameter of 56cm in a circular pattern which was filled with sterilized garden humus soil obtained from the experimental site at the depth of 3cm and which was subsequently watered. A flat plastic container was used as feed saucer and contained their feed which was placed at the middle of the bowl. The bowl was then covered with mosquito netting material and tied with a twine to avoid intrusion of insects. The proximate analysis of the test ingredient (Whole jackfruit) and the experimental diet are presented in table 2 and 3 respectively

The snails were fed once a day, in the evenings due to the snail's nocturnal feeding habit. They were served with a feed saucer which was cleaned on daily basis. The snails in treatment one (T_1) were fed with diet without any inclusion of whole jackfruit meal, those in T_2 had 5% level of inclusion of WJM, T_3 had 10% level of inclusion of WJM and T_4 had 15% level inclusion of WJM as shown in table 1. The feed saucer was cleaned daily before introduction of fresh feed. The droppings of the snails were removed on daily basis, the corners of the bowls were cleaned on daily basis while the tops of the media were scrapped off on weekly basis to prevent soil from sticking together which could arise as a result of their slime. The soil was pulverized and watered to make it moist.

The feed intake was measured by subtracting the feed refused from feed offered on daily basis. The shell length and shell girth were measured using Vernier caliper on weekly basis. The shell thickness was measured using a micrometer Screw guage at the beginning and end of the experiment. The shell aperture circumference was measured using a thread and meter rule on weekly basis. The weight gain was measured using a sensitive scale on weekly basis. The proximate analysis to chemically evaluate the nutritional potential of the whole jackfruit meal and experimental diets were determined by the methods of AOAC (2002).

Results and Discussion

The oven dried jackfruit meal used in the experiment had dry matter content of 92.5%. It contained also ash of 4.75%, crude protein of 11.34%, crude fibre of 5.85, nitrogen free extract of 65.66% and a metabolizable energy (ME) of 3619.61 Kcal. The moisture content here differs from

Reza(2014) report on moisture content of 72% and Tang (2013) of 83% and this could be traced to the oven drying to which the jackfruit was subjected to as compare to the wet basis analysis of the two authors mentioned.
The result obtained on the average daily feed intake and total feed intake of the snails showed that there was no significant difference (P<0.05) between the snails subjected to the four dietary treatments. Though there is no significant difference between the feed diets, T_4 with 15% inclusion of jack fruit meal gave higher feed intake value and this could be due to the fact that T_4 had the least Nitrogen free extract (carbohydrate) and according to Ivan (1994) livestock feed mainly to meet their energy requirement.

The results obtained on the feed conversion ratio of the snails showed that there is a significant difference amongst treatments. The study revealed that T_4 had the highest conversion ratio and this could be due to the higher fibre content in the diet. T_3 and T_2 had the least feed conversion ratio and this could be due to lower fibre content in their diet when compared with T_4. The results revealed that there were significant differences (P<0.05) between the total weight gains of *Archachatina marginata.* Snails fed T_4 (15%) inclusion level of jackfruit meal gave higher weight, followed by T_1 with inclusion level of 0%. T_2 and T_3 were least and not significantly (P>0.05) different from each other. This could be attributed to the different gross energy value of the experimental diet.

The results of the shell growth characteristics of *Archachatina marginata* fed whole jackfruit meal based diet is presented in table 4. The results obtained on shell length showed that there was no significant different (P>0.05) in the shell length increment amongst the diet. This could be due to the similar ash content of the diet. The result obtained on shell aperture increase showed no significant difference (P>0.05) between the *Archachatina marginata* fed with the four treatment diets. This agrees with work by Ejidike *et al* 2010 that there was no significant difference on the shell aperture of *Archachatina marginata* specie of snails fed on different treatments. Though there were no significant difference; snails on treatment diet with 0%(control) inclusion level had a higher increase in shell aperture and this could be traced to the protein content of the treatment (19.63%) which is in close proximity to Ejidike *et al* report of 2010. The result obtained on the increment on shell girth of *Archachatina marginata* revealed that there was no significant difference (P>0.05) between the shell girth of the snails fed on the different dietary treatments. This is in line with the work of Ejidike (2016) which states that each of the study animal in the diet treatments did not differ significantly (P>0.05) at the end of the study period. The no significant difference in the shell girth increase of snails fed the different dietary treatment could be attributed to the relatively similar ash content of the diets. The result obtained on shell thickness of *Archachatina marginata* revealed that there was no significant difference (P>0.05) between the shell thickness of the snails fed with the different treatment diets. This result is in agreement with the work of Adeniji *et al (*2014) and Ejidike (2010) which recorded no significant difference on the Increment of shell thickness. *Archachatina marginata* fed on dietary ingredient with 15% inclusion (T_4) had the least level of thickness and this could be attributed to the lower protein content compared with other treatment.

The feed cost evaluation of *Archachatina marginata* fed whole jackfruit meal based diet is shown in table 5. The study recorded a lower feed cost as the inclusion level of Jack fruit meal increased T_4 had the lowest feed cost and T_1 had the highest feed cost this could be attributed to the cheap (free) sourcing of the alternative feed ingredient. This assertion can be traced to the work of Bijaya (2016) that locally available products benefits the farmer as it reduces the feed cost which in turn can reduce the total cost of production. Result of cost of feed intake showed that T_4 had the least cost of feed intake and T_1 had the highest cost of feed intake this could be attributed to the lower feed cost of T_4. Also it was recorded that though T_2 had a higher feed cost than T_3, T_3 had a higher cost of feed intake than T_2, this also could be attributed to the higher feed intake of snails fed with T_3 diet. Feed cost per weight gain which is also the cost of production recorded T_1 with the highest cost of production and T_4 with the least; this could also be attributed to the feed cost.

Conclusion

The results of the proximate analysis carried on the WJFM (test ingredient) proved that it possessed enough quality that makes it a good source of feed stuff for livestock in Nigeria. Whole jackfruit meal incorporated into the feed of Giant African Land snails at 15% inclusion level gave a better result in the area of growth performance also on the cost effectiveness, so whole jackfruit can comfortably use as an energy feed resource to replace or substitute maize.

Table 1 Percent composition of feed ingredients of snails fed with different levels of jack fruit meal

Ingredients	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)
Maize	49.25	44.25	39.25	34.25
Cassava Flour	11.00	11.00	11.00	11.00
WJPM	0.00	5.00	10.00	15.00
Soybean cake	15.00	15.00	15.00	15.00
Fish meal	3.00	3.00	3.00	3.00
Wheat offal	10.00	10.00	10 00	10.00
Palm kernel cake	3.00	3.00	3.00	3.00
Bone meal	5.00	5.00	5.00	5.00
Limestone	3.00	3.00	3.00	3.00
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
TM/Vit premix	0.25	0.25	0.25	0.25
Total	100	100	100	100

Table 2. Chemical composition of the experimental diets

Parameters	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)
Dry Matter	90.42	90.43	91.01	91.22
Moisture	9.58	9.57	8.99	8.78
Ash	11.8	12.06	11.7	13.17
Crude Protein	19.63	19.42	19.31	18.94
Crude Fibre	4.20	4.44	4.56	4.75
Nitrogen Free Extract	53.56	53.21	54.17	52.51
Ether Extract	1.15	1.30	1.18	1.85
Gross energy	2981.84	2965.17	3006.24	3184.82

Table 3: Proximate Composition of Whole Jackfruit meal

Parameters	Quantity
Dry Matter	92.50
Moisture content	7.50
Ash	4.75
Crude Protein	11.34
Ether Extract	4.90
Crude Fibre	5.85
Nitrogen Free Extract	65.66
Metabolizable Energy	3619.61

Table 4: Shell Growth Characteristics of *Archachatina marginata* fed whole jackfruit meal based diet.

Parameters	T1	T2	T3	T4
Shell length initial	7.72	7.82	7.79	7.718
Shell length final	7.85	7.901	7.86	7.86
Shell length increase	$0.13^{a}\pm0.056$	$0.09^{a}\pm0.08$	$0.07^{a}\pm0.05$	$0.15^{a}\pm0.06$
Shell girth initial	4.36	4.40	4.31	4.42
Shell girth final	4.49	4.54	4.44	4.52
Shell girth increase	$0.14^{a}\pm0.06$	$0.15^{a}\pm0.02$	$0.13^{a}\pm0.05$	$0.10^{a}\pm0.05$
Shell aperture initial	12.11	12.25	12.18	12.15
Shell aperture final	12.51	12.57	12.45	12.55
Shell aperture increase	$0.40^{a}\pm0.18$	$0.33^{a}\pm0.22$	$0.26^{a}\pm0.15$	$0.40^{a}\pm0.02$
Shell thickness initial	1.21	1.23	1.23	1.24
Shell thickness final	2.27	2.34	2.36	2.13
Shell thickness increase	$1.06^{a}\pm0.05$	$1.11^{a}\pm0.27$	$1.13^{a}\pm0.14$	$0.89^{a}\pm0.06$

Rows sharing similar subscript are not significantly (P>0.05) different from each other

Table 5: Growth Performance Characteristics and Cost Evaluation of *Archachatina marginata* fed whole jackfruit meal based diet.

Parameters	T1	T2	T3	T4
Average daily feed intake.	$0.58^{a}\pm0.01$	$0.59^{a}\pm0.09$	$0.63^{a}\pm0.06$	$0.63^{a}\pm0.05$
Total feed intake	$28.33^{a}\pm0.45$	$28.87^{a}\pm4.32$	$30.77^{a}\pm2.88$	$31.07^{a}\pm2.58$
Total weight gain	$5.63^{b}\pm1.70$	$4.83^{b}\pm1.20$	$5.23^{ab}\pm0.51$	$8.10^{a}\pm1.90$
Average daily weight gain	$0.12^{b}\pm0.04$	$0.10^{b}\pm0.025$	$0.11^{ab}\pm0.01$	$0.17^{a}\pm0.04$
Initial weight gain	65.23	67.73	68.63	65.97
Final weight gain	70.87	72.57	73.87	74.07
Feed cost per weight gain	24.23	28.10	28.10	17.64
Feed cost	0.17	0.16	0.16	0.15
Cost of feed intake	4.817	4.71	4.78	4.60
Feed conversion ratio	$5.03^{ab}\pm1.64$	$5.97^{a}\pm2.41$	$5.88^{a}\pm0.77$	$3.84^{b}\pm0.64$

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SUB-THEME 4


FOREST RESOURCES, WILDLIFE AND ENVIRONMENTAL MANAGEMENT ISSUES AND STRATEGIES

ASN 52nd Annual Conference Proceedings

Assessment of Awareness Level of existing Tourist Centres among Inhabitants of Ogun state

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Abstract
In spite of the vast natural and cultural resources which Nigeria is endowed with, the country tourism industry has not grown significantly. The study was carried out to assess the awareness of tourist centres among citizens in Ogun state. Random sampling technique was used for selecting the respondents in the study. The result showed that most of the respondents were male (52.5%) and below 40 years (61.6%), married (59.2%) and had formal education (89.2%). They were low income earners as 54.2% earned less that ₦20,000. Also, the level of awareness of the respondents about tourist centres in the state was high among the male and those between age 20 and 39 years compare to those who are 40 years and above. The level of awareness was high among those between 20 and 39 years, and the respondents who possessed tertiary education. There was a significant difference in level of awareness (p<0.05). Olumo rock (77.5%), Ake palace (61.6%), Yemoji resort centre (47.5%) were rated the most the popular tourist centres in the state. There should be more adverts on tourism in the state and the facilities around the tourist centres should be developed.
Keywords: Tourism, development, facilities and potentials

Introduction
Tourism is a term defined as the science, art and business of interacting and transporting visitors, accommodating them and graciously catering for their needs and wants (Ayodele and Falade, 1989). This implies that any activities that voluntarily and temporary takes a person away from his/her usual place of residence in order to satisfy a need either for pleasure, excitement, experience and/or relaxation can be termed as tourism. Tourism has the potentials of contributing to country's revenue, economic growth and generating foreign exchange for Nigeria, and create more jobs for people in hospitality industry (Falade-Obalade and Dubey, 2014; WTO, 2011; Ijeomah, 2007). And by developing the tourism in the state, government would tackle economic problems and solve social amenities and infrastructural development problems (Kukoyi *et al* 2016). Nigeria is endowed with abundant natural resources and a wide spectrum of cultural heritage which are great asset to the country's tourism development (Uluocha, 2014). The nation is also blessed with an excellent climate with sunshine year round, vast tracts of unspoiled nature ranging from tropical forest, magnificent parks and protected areas, waterfalls, unique wildlife, beautiful rivers and beaches. Its cultural attraction include many national museum, ancient slave site, palaces and shrines, well preserved local customs. However, Nigeria tourism industry has not grown significantly. Tourism in Ogun state was in poor condition before year 2003, when Gateway Tourism Development Corporation (GTDC) was established. This tourism organization was saddled with the responsibilities of ensuring a proper coordination of all activities of tourism that include among others the festivals, sports tourism, sites, hotels, eateries and others. The board was to also resuscitate the facilities in various tourist centres which were in deplorable situation. The study will add to existing body of knowledge by assessing the awareness level of tourism among in Ogun state. The specific objectives are to study the level of tourism awareness among the people in Ogun state, identify various tourism

sites in the State, assess the facilities and infrastructures available for use by tourist and identify the challenges faced by the tourists.

Methodology

Study Area

Ogun State is located in South-West geo-political zone of Nigeria. It lies within latitude 7°00'N and longitude 3°35'E with a total land area of 16,762 square km. The State with the appellation ''Gateway state'' is bounded in the West by Republic of Benin, in the East by Ondo in the North by Oyo and in the South by the Atlantic Ocean on one part and Lagos State on the other (Nigeria Bulletin, 2015). Ogun State comprises of twenty (20) Local Government Areas.

Data collection and analysis

Primary data was used for the study. Data was obtained through the use of structured questionnaires administered to one hundred and twenty (120) respondents randomly selected. Data was analyzed using descriptive (frequency counts and percentages) and inferential statistics (chi-square).

Results and Discussion

Socio-economic characteristics of the respondents

Table 1 revealed that most of the respondents were male (52.5%) and below 40 years (61.6%), indicating that most of the respondents were young people. Most of the respondents were married (59.2%) and 89.2% had formal education (10.0% had primary education, 34.2% had secondary and 45.0% possessed tertiary education). They were low income earners as 54.2% earned less that ₦20,000.

Table 1: Demographic information of the respondents

Variables	Frequency	Percentage
Age		
Below 20years	22	18.3
20-39	52	43.3
40-59	39	32.5
60years and above	5	4.2
No response	2	1.7
Sex		
Male	63	52.5
Female	55	45.8
No response	2	1.7
Marital Status		
Single	49	40.8
Married	71	59.2
Total	120	100.0
Educational Background		
No education	13	10.8
Primary education	12	10.0
Secondary education	41	34.2
Tertiary education	54	45.0
Estimated Monthly Income (₦)		
Below 10,000	33	27.5
11,000-20,000	32	26.7
21,000-30,000	12	10.0
Above 30,000	19	15.8
No response	24	20.0

Source: Field Survey.

In Table 2, the level of awareness about tourist centres was high among the male than female. Based on age, the level of awareness is high among those between 20 and 39 years compare to those who were 40 years and above. According to EUROPA (2018) the share of older people participating in tourism is lower than the share of general populace above 15 years (EUROPA, 2017). One the main drivers of the young people to tourist centre is curiosity. Tourists visit the centres for education, entertainment (pleasure) and religious purposes. They want more information. On the basis of education, those who possessed tertiary education were more aware of the tourist centres than others

Table 2: Level of awareness of tourist centres in the state based on sex, age, and level of education

		Aware	Not Aware
Sex	Male	60(54.05)	3(42.86)
	Female	51(45.95)	4(57.14)
Total		111(100)	7(100)
Age	Below 20years	21(18.92)	1(14.29)
	20-39 years	50(45.05)	2(28.57)
	40-59 years	35(31.53)	4(57.14)
	Above 60years	5(4.50)	-
Total		111(100)	7(100)
Level of Education	No education	13(11.50)	-
	Primary education	12(10.62)	-
	Secondary education	37(32.74)	4(57.14)
	Tertiary education	51(45.13)	3(42.86)
Total		113(100)	7(100)

Source: Field survey. Values in parentheses are percentages.

Considering the level of awareness of the respondents of tourist centres in the state, Olumo rock in Abeokuta was rated the most the popular tourist attraction (77.5%), followed by Ake palace (61.6%), Yemoji resort centre (47.5%) and the least being oronna shrine (1.7) (Table 3). Table 4 showed a significant difference in the level of awareness ($p<0.05$). On the present state of tourist centres in the State, most of the respondents remarked that tourists centres were in average condition. This supports Olatunji (2016) who reported similar findings in Osun state.

Table 3: Awareness of tourist centre in the state by respondents

Tourist site	Aware	Not aware
Olumo rock	93 (77.5)	27 (22.5)
Ake palace	74(61.6)	46(38.3)
Yemoji resort centre	57 (47.5)	63 (52.5)
Birikisu Sungbo tourist complex	18 (15.0)	102 (85.0)
Abeokuta golf resort	5 (4.2)	115 (97.8)
Suna cultural centre	3 (2.5)	117 (97.5)
Oronna shrine	2 (1.7)	118 (98.3)

Source: Field survey. Values in parentheses are percentages.

Table 4: Level of Awareness of tourist centre among the respondents in the state

	Observed N	Expected N	Df	X	P-value	Remark
Aware	113(94.2%)	60	1	936.633	0.001*	Significant
Not Aware	7(5.8%)	60				
Total	120					

*Significant at 0.05 level of significance

The available facilities observed around the tourist centres by respondents include picnic site, restaurants, children playground and hotel (Table 5).

Table 5: Facilities available in the tourist centres

Facilities available in the tourist centre	Available	Not available
Picnic site	47 (39.2)	73 (60.8)
Restaurant	34 (28.3)	86 (71.7)
Children's playground	23 (19.2)	97 (80.8)
Hotel	13 (10.8)	107 (89.2)

Values in parentheses are percentages.

Conclusion

The study was carried out to assess awareness level of tourist centres among citizens in Ogun state. It is concluded that level of awareness was high among the respondents. Although the level of awareness was high among the respondents, there are still those who are aware of some tourist centres in the state. Therefore there should be more campaigns and adverts about the potentials of tourism in the state. Also, facilities around these tourist centres should be developed to attract more tourists.

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Assessment of the Effects of Roof Catchments on Physiochemcial Qualities of Harvested Rainwater for Domestic Use in Umuahia Metropolis, Abia State, Nigeria

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Abstract
This study was carried out to determine the effect of different roof catchments on the physiochemical quality of rainwater harvested for domestic consumption in Umuahia Metropolis in the month of April as such determine the roofing material most suitable for rainwater harvesting. The overall water resources were assessed by the application of water quality index (WQI). Analysis of physiochemical properties in sampled rainwater were subjected to ANOVA among the roofing materials and the mean differences were separated using Duncan Multiple Range Test. The level of pollution between the sampled rainwater was made comparing the results of the physicochemical parameters to WHO and FMEnv for portable uses. The result showed that asbestos roof catchment recorded the highest mean values except in zinc where corrugated iron sheet recorded the highest. However, all the values obtained for physiochemical properties fell within the WHO & FMEnv permissible limit except zinc from corrugated iron sheet which recorded 4.35mg/l above the WHO limit of 3.0mg/l but within FMEnv limit of 5.0mg/l. Notably, Lead was detected only in Asbestos during the month of April. From the calculation of WQI, all roof catchments in all the months exceeded the critical value of 1.0 used to judge unpolluted water and therefore should be subjected to treatment for portable purposes. SRC4 (Harvey-tiles) proved to be the most suitable roof catchment for rainwater harvesting, followed by SRC2 (Aluminum rooftop). However, it is advised to subject rainwater from roof catchments to further treatments especially if it must be used for drinking.

Introduction
Water is essential to all forms of life. It is second in ranking, next to air in the list of human daily needs. As a result, it is in high demand as it represents a unique resource in every settlement: for drinking, sanitation, washing, fishing, recreation and industrial processes. Therefore, Aderogba, (2005) has posited that access to clean and regular water supply is a basic human right as its access to unadulterated food. Irrespective of the vital nature of this resource, the World Water Council has predicted that the need for water within the next fifty years will boost due to a prediction of 40-50% population growth coupled with industrialization and urbanization (Mahmoud *et al*., 2014). It is as a result of this that estimations has been made that about two billion people will be short of access to safe drinking water by the middle of this century (Parmar, 2003). The provision of water for domestic and other uses in rural and urban centres is one of the most intractable problems in Nigeria today, with 52% of Nigerians lacking access to improved drinking water supply (Lekwot *et al*., 2012; Orebiyi *et al.,* 2010). Even though Nigeria is endowed with enormous surface and groundwater resources, the provision of potable and safe water supply is still inadequate (Nwankwoala, 2011). In tackling this problem of limited access to water, identification and utilization of additional sources of water to supplement existing or dominant sources becomes paramount, where a crucial source identified is harvested rainwater (Opare, 2012). Rainwater harvesting technology comprises of three essential stages, which includes catchment areas (rooftops and land surfaces), conveyance systems (plastic or corrugated iron gutters) and collection devices (storage tanks). Among the various catchments

for the harvesting of rainwater, roof catchment seems to be the most common. This can be attributed to the fact that households use existing roofs of their houses with no additional costs incurred but the quantity and quality of rainwater collected is dependent on the area and kind of roofing material (Olaoye and Olaniyan, 2012). Chang *et al* (2004) reported that roofs can also be a crucial source of non-point source pollution as well. Efe (2006) assessed the level of portability of rainwater samples collected from thatch, aluminum, asbestos, corrugated iron roofing sheets, and open surfaces from catchment's roofs in 6 rural communities of Delta State, Nigeria. The result revealed that most of physiochemical characteristics of rainwater samples were generally below the WHO threshold, as such the rainwater characteristics showed satisfactory concentration in these rural communities. In Abeokuta Ogun State of Nigeria, Aladenola and Adeboye (2009) addressed the potential of rainwater from roof catchments commonly used in the area and concluded that Rainwater collection systems can provide water for purposes not requiring drinking water quality. Rainwater from Aluminium roofing sheet proved to be most suitable. The work of Olaoye and Olaniyan (2012), found out that all the physical and most of the chemical parameters analyzed from rainwater harvested from different roof tops conformed to the recommended standard value apart from chloride and total hardness value. In the research of Beatrice and Onakufe, (2000), Rainwater samples collected directly from the atmosphere and through various roof catchments (aluminium, zinc, asbestos and thatch) were analysed for their physical, chemical and microbiological qualities in Rivers State. Results showed that the physical and chemical qualities of the rainwater, except for colour, were within the limits approved by the World Health Organization (WHO). Galvanized iron roofing sheet appeared to be a better material for rainwater collection than aluminum, asbestos and thatch

Several studies have looked at the effect of roofing material on harvested rainwater quality but common roofing materials and coatings will vary across the country and the world. This research will therefore focus on assessment of the effect of different rooftops on rainwater quality to ascertain their suitability for domestic consumption in Umuahia metropolis, Abia State, Nigeria.

Methodology

Study area

The study was carried out in 3 layouts in Umuahia Municipal, New town layout, Eghem layout and Uzo Avoiteyi layout of Abia state in Southeast, Nigeria. It is found in the tropical rain rainforest zone of Nigeria on latitude 5.5250^{o}N and longitude 7.4922^{o}E with a population of 147,167 (NPC, 2006). Umuahia experiences the two seasons in a year; the rainy season (March-October) and the dry season (November-February) with a break in August usually referred to as the "August break".

Sampling procedure

A random sampling technique was adopted for the study within the three layouts in the study area on the basis of the availability of the selected roof catchments. The technique was employed in selecting four buildings each with the four identified roof types, namely; asbestos roofing sheet, aluminum roofing sheet, corrugated iron sheets and Harvey-tiles rooftop. The four types of existing roof materials were designated SRC, signifying Sample Roof Catchments, in which;

(i) Asbestos Rooftop (SRC1)
(ii) Aluminum Rooftop (SRC2)
(iii) Corrugated Iron Rooftop (SRC3)
(iv) Harvey-Tiles Rooftop (SRC4)

Above all, rainwater was harvested directly from the atmosphere as control signifying atmosphere.

Stainless basins were placed on elevated- wooden stands above the ground surface for rooftops rainwater samples, while the one directly from the atmosphere involved placing basins on the rooftops to avoid splashing. The samples were then crammed and put into clean polythene bottles, corked and labeled according to the different roof catchments then placed in freezers that contains ice block. This study was conducted in the month of April, the beginning of rainfall season. All rainwater samples were packaged and taken to the laboratory for physiochemical analysis.

Data analysis

Results of data collected were subjected to descriptive statistics which illustrated the means and standard deviation from replicates of data collected. Means of the collected data was afterwards subjected to mean separation using Ducan Multiple Range Test.

Application of water quality index (WQI)

Water quality index expressed the pollution level of water bodies developed and used by Horton (1965). This is expressed mathematically:

$P_{ij} = (maxCi/Lij)^2 + (meanCi/L$……………………..(1)

Horton (1965), used multiple items of water qualities as expressed as *Ci's* and permissible levels of the respective item expressed as L_{ij}*'s*. then the pollution index, *Pij* may be expressed as a function of the relative values of Ci/L_{ij} (Horton, 1965).Here, *i* is the number of the *ith* item of the water quality and j is the number of the j-th water use. Each value of (Ci/L_{ij}) shows the relative pollution contributed by the single item. A value of 0.1 is the critical value for each (Ci/L_{ij}). Values greater than 0.1 indicates that the water requires some treatment prior to use for specific purpose. Combining the mean value of Ci/L_{ij} into a common index, values over 1.0 signify a critical condition under which a proper treatment is needed for portable water.

Horton proposed that, the pollution index of water can be computed using the multiple items of water qualities and permissible levels of the respective items for use. If Pij is the pollution index then:

$P_{ij} = F\{C_i/L_{ij}, C_2/L_2j. C_3/L_j$………………. $C_i/L_{ij}\}$ ………. (2)

This is then applied in the study of water resources to know the pollution level and the treatment expected.

Results and Discussion

From Table 1, it was observed that all parameters were below the WHO acceptable limits for portable use except in Corrugated iron sheet which recorded a zinc value higher than WHO permissible limits. This is close to the findings of Efe (2006); Beatrice and Onakufe (2000). Of interest is the rainwater sample from asbestos roofing sheet which had the highest mean value in all the parameters, in agreement with Olaoye and Olaniyan (2012). According to Achadu *et al*. (2013) higher acid value in rainwater harvested from Asbestos roof type could be attributed to its lower pH and the presence of washed off particles from the Asbestos roof type by the rain. Similar observation was reported by Eruola *et al*., (2010) on rainwater harvested from Asbestos and other roofing materials in Abeokuta, Nigeria. The variations in the conductivity values obtained could be due to the type of roofing materials which could have an impact on the chemical properties of the harvested rainwater. The comparable higher value of nitrate obtained from Asbestos roof type is an indication of the presence of some biological materials like droppings from birds that stick on the coarse surface of the Asbestos roofing material. The higher sulphate content obtained in the rainwater from the roofing materials compared to the control is an indication that the roofing materials accumulate these ions from the droppings of birds and roof climbing animals or other unknown processes. The absence of lead in other rooftops except in asbestos indicates that there is minimal concentration of Lead in the environment that could be carried to the rooftops and washed into the rainwater. The presence of iron (FE) in rainwater harvested from aluminum roof type and corrugated iron sheet roof type could be due to the fact that the rain run-offs on the roof tops washed off some iron which is part of the material used in their manufacturing. The higher zinc value found in corrugated iron sheet is not surprising as eroded particles of zinc are washed off by runoff water from the corrugated iron sheet rooftop. From the calculation of water pollution index (WPI) in Table 2, it is observed that rainwater in the study area from Asbestos (SRC1) recorded the highest pollution value (6.39) which indicated that rainwater from asbestos was heavily polluted with physicochemical tracers because the calculated value is more than critical value of 1.0 used for the judgment of unpolluted water. Worthy of note is that Harvey-tiles roof catchment (SRC4) had the lowest pollution index value (1.37) making it the most suitable followed by aluminum roof catchment (2.56). This is close to the findings of Aladenola and Adeboye (2009) who reported that aluminum rooftop was found most suitable in their work and in disagreement with Beatrice and Onakufe, (2000) who reported that corrugated iron sheet was more suitable than aluminum rooftop.

Table1: Statistical summary of the physiochemical properties of early harvested rainwater from different roof catchments

Roof Catchment	pH	Acidity mg/l	TDS mg/l	EC mg/l	NO_3^- mg/l	SO_4^{2-} mg/l	Cl^- mg/l	Cu (mg/l)	Pb (mg/l)	Fe (mg/l)	Zn (mg/l)
SRC1	6.20^e	28.58^a	46.00^a	64.00^a	2.66^a	13.16^a	14.03^a	ND	0.04	ND	1.16^b
SRC2	6.55^c	22.19^c	28.50^c	52.00^c	0.22^c	3.86^c	9.18^c	ND	ND	0.22^b	0.43^c
SRC3	6.35^d	25.09^b	39.00^b	57.50^b	0.66^b	5.20^b	10.42^b	ND	ND	0.40^a	4.35^a
SRC4	6.75^b	14.43^d	16.00^d	26.50^d	0.13^{cd}	1.09^d	6.45^d	ND	ND	ND	0.22^{cd}
Control	6.90^a	10.01^e	8.00^e	13.00^e	0.05^d	0.47^d	4.13^e	ND	ND	ND	0.03^d
Total mean	6.55	20.06	27.50	42.60	0.74	4.76	8.84	0	0.008	0.044	1.238
S.E	**0.05**	**0.31**	**0.71**	**1.00**	**0.06**	**0.42**	**0.23**	**0.00**	**0.00**	**0.03**	**0.12**
WHO	**6.5-8.5**	**100**	**250**	**100**	**40**	**250**	**250**	**1.0**	**0.01**	**0.3**	**3.0**
FME$_{NV}$	**6.0-9.0**	**-**	**500**	**-**	**10**	**500**	**250**	**0.1**	**0.05**	**1.0**	**5.0**

SRC1 = Asbestos roof catchment, SRC2 = Aluminum roof catchment, SRC3 = Corrugated iron roof catchment, SRC4 = Harvey-tiles roof catchment, C = Atmospheric rain. Means with same superscript are not significantly different (P ≥ 0.05) from each other. TDS=Total Dissolved Solid: EC=Electrical Conductivity: NO_3^-=Nitrate: SO_4^{2-}=Sulphate: Cl^-=Chloride: Cu=Copper: Pb=Lead: Fe=Iron: Zn=Zinc: S.E=Standard Error of Means: WHO=World Health Organization: FME$_{NV}$ = Federal Ministry of Environment.

Table 2: Composition of pollution index of harvested rainwater

Water Tracer	Water Quality Index SRC1		Water Quality Index SRC2		Water Quality Index SRC3		Water Quality Index SRC4		Level (WHO) *Li*
	Ci$_1$	***Ci$_1$/Lij***	***Ci$_2$***	***Ci$_2$/Lij***	***Ci$_3$***	***Ci$_3$/Lij***	***Ci$_4$***	***Ci$_4$/Lij***	
pH (H_2O)	6.20	0.73	6.55	0.77	6.35	0.75	6.75	0.79	**8.5**
Acidity (Mg/l)	28.58	0.29	22.19	0.22	25.19	0.25	14.43	0.14	**100**
TDS (Mg/l)	46.00	0.18	28.50	0.11	39.00	0.16	16.00	0.06	**250**
EC (Mg/l)	64.00	0.64	52.00	0.52	57.50	0.58	26.50	0.27	**100**
NO_3^- (Mg/l)	2.66	0.07	0.22	0.006	0.66	0.02	0.13	0.003	**40**
SO_4^{2-} (Mg/l)	13.16	0.05	3.86	0.02	5.20	0.02	1.09	0.004	**250**
Cl^- (Mg/l)	14.03	0.06	9.18	0.04	10.42	0.04	6.45	0.03	**250**
Cu (Mg/l)	ND	ND	ND	ND	ND	ND	ND	ND	**1.0**
Pb (Mg/l)	0.04	4.0	ND	ND	ND	ND	ND	ND	**0.01**
Fe (Mg/l)	ND	ND	0.22	0.73	0.40	1.30	ND	ND	**0.3**
Zn (Mg/l)	1.16	0.37	1.16	0.14	4.35	1.45	0.22	0.07	**3.0**
Overall Water Quality Index	**∑ *Ci$_1$/Lij* 6.39**		**∑ *Ci$_2$/Lij* 2.56**		**∑ *Ci$_3$/Lij* 4.57**		**∑ *Ci$_4$/Lij* 1.37**		

Conclusion

Rainwater Harvesting is an environmental sustainable alternative for water supply. It is the simplest way to ensure the availability of water in areas experiencing water scarcity and from this study; it has been observed that its quality varies from the type of roof catchments. This study revealed that the values of the physiochemical properties of the harvested rainwater samples fell within the WHO and FMEnv standard limits except for zinc. However, from the pollution index, rainwater from Harvey-tiles is the most suitable followed by aluminum rooftop while asbestos had the highest level of pollution followed by corrugated iron sheet. By these findings, rainwater could serve as an alternative water source for domestic uses like washing, bathing and cleaning, and should be subjected to proper treatment if it must be used for drinking purposes. Harvey-tiles should be encouraged for building rooftops and where unaffordable, aluminum should be used for the purposes of harvesting rainwater. The roof catchments should be cleaned up regularly to ensure a good water quality. The first rainfall events regarded as first flush should also be diverted away from the storage system as this is usually the most polluted rainwater because of accumulated dust particles from the dry season. Rainwater is advised to be filtered to remove debris which accumulates in the roof catchments by the use of rapid sand filter while chlorination and boiling should be used as treatment methods if rainwater must be used for portable use.

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Role of Forestry in Health Care Delivery

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Abstract
This paper is based on ethno-medical survey of some medicinal plants used to treat different ailments including internal, external infections and parasitic diseases as well as poisons. It was discovered that some of these vital medicinal plants are going extinction due to human activities without replacing them back. The control the uncultured activities, a total awareness about the importance of tree plant for medicinal properties should be created generally by the Government and forestry Department. The importance of trees herb in curing ailment should be brought to the people through health care delivery and the Government proper documentation in research should be made.
Keywords: Ethno-medicine, health care, ailments and Forest

Introduction
Forests have been known since ages to provide certain amenities for the benefits of mankind which include environmental protection, ecotourism services, revenue and medicine. Forests have, in one way or the other, contributed and still contributing to the socio-economic, cultural and environmental development of the people all over the world. In the developing world, forest provides a basis for the daily living of the people. The world's tropical rainforest are especially rich in biodiversity both fauna and flora that are immense benefits to man whose potentials have not been fully utilized. The socio cultural and economic values of forest plants are numerous and should not be ignored. Forest provides vast number of food which includes tuber, nuts, edible leaves, barks, roots and honey (Alves and Rosa 2007).
Forests have long been recognized as major contribution to the socio-economic, cultural and environmental development of the world at large. Plants of the tropics are means of meeting the basic needs of the rural sustaining in rural and urban which provides employment and income, maintaining the environmental stability needed for continued food production and purifying the atmosphere. Plants contribute to the wellbeing of the rural people by providing forest foods which are important dietary supplements mainly during period of agricultural cycle when production tends to be low. Rural nutrition could be improved in Nigeria through forestry programmed as there are numbers of indigenous forest plants or trees known for providing edible fruits and seeds, spices, fats and oil are also obtained from Nigeria plant (FAO, 1985). Forests provide food supply for human, wild life consumption, in many parts of Nigeria and livestock (NEST, 1991).
Plants roots, barks, leaves and twinges have contributed immensely to rural health through provision of drugs for the treatment of many ailments. Huge foreign exchange should have been saved from the singular contribution of *Azadiracha indica* to the treatment of malaria. An extract obtained from *Rauwolfia* specie is generally considered to provide the best known treatment against high blood pressure (Isebemhe, 2000).

Forest as phytomedicinal and pharmaceutical source
Department of Health, Medicine Research Unit and Control of Scientific and Industrial Research (CSIR) in America (2005) reported that medically, no plant is useless, in other words, all plants have medicinal uses. If a plant is deemed medicinally useless" it is just that its use or uses not yet known. The use of traditional herbal medicine is very common in Nigeria as in other parts of the

world such as Ghana, Ethiopia, Kenya, Gambia, Cameroun, China, India, Sri Lanka, Bangladesh and Brazil. Universally, despite modern development in the treatment of the human body, herbal remedies have been continuously used. Modern medicine in the beginning depended on the herbal remedies for plants were the fundamental sources of therapeutic products for professional and non-professional healers of the earliest times. The efficacy of herbs has been confirmed in different disease condition all over the world. Herbs have succeeded where conventional or synthetic medicine has failed, especially in chronic diseases. Apart from this efficacy, it is very important to mention the little or no side effects in the treatment of diseases because they act as foods and as medicines. In the treatment of hypertension, for instance, herb is used first to lower the blood pressure; to clean the arteries, to slow and regulate the heart rate, to improve the blood circulation and to relax the mind unlike the conventional ones that will dilate the arteries or the veins until they reach their maximum elastic point which may suddenly burst and cause vascular accident, causing stroke or death. There are a few or no synthetic drugs that will do all of the above. People all over the world have used to cure and control different diseases that are peculiar to their sub-regions and Nigeria is no exception. Malaria and sickle cell are examples of diseases in this sub-region. If researchers work harder and in humility into natural remedies, we will find more than fagara Root, Almond Leaves (for sickle cell); Ewedu Root, Siam weed; Asurun Oyibo (for malaria) within this sub-region (Igoli *et al*., 2005). Preparation from leaves, roots, bark, flowers, fruits and seeds are employed for curing elements in various ways, some are coked together and taken as tea. These are commonly used for ailments such as fever, pile and dysentery. While some may be cut into pieces such as roots, stems, fruits, seeds are soaked in cold water for strong drinks. Other forms in use include and the powdered form tooth ache, *Vernonia amydalina, Garcinia Kola* etc. Roots of *Cola nitida* and *Cola acuminata* are excellent chewing sticks. They clean the teeth, disinfect the mouth and strengthen dental gums (Farombie *et al.*, 2005). Some medicinal plants are cooked as soup especially for pregnant women these plants are traditionally employed in a variety of ways sweetness anti-infection, moluscides, anti-malaria, laxative, cardiovascular nervous disease treatment in Ghana more than 800 wild plants and many other herbaceous species are known for their medicinal properties (Berhan *et al.*, 2006).

Role of African leafy vegetables in health promotion and protection

Quite a large number of Africa indigenous leafy vegetables have long been known and reported to have health protecting properties and uses. Ozumba, 2008 observed that the roots, leaves and twigs as well as the bark of the tree of *Moringa Oleifera* are used in traditional medicine. Several of the indigenous leafy vegetables continue to be used for prophylactic and therapeutic purpose by rural communities (Githens, 1949; Igoli *et al.*, 2002). Some herbs are common and others are not common. The common ones have become so well known that they are daily used as vegetables, it is well known fact that the body's requirement are more in what we get from vegetables, herbs and fruits more than in any other food. Because of this, it is easier and more natural to repair worn out organs, to cleanse the blood and to keep the body fit by the use of herbs. The history of how long herbs have been in use is as far back as man's history. The properties of herbs show clearly that they have direct relevance to the chemistry of the body and are therefore used to repair and activate the system more effectively without side effects. The body's acceptance and assimilation of herbs shows that herbs are natural needs to the body. The human body is made up of organic substances such as phosphorus, potassium, sodium, Zinc, sulphur, Magnesium, Chlorine, Calcium and others. All these are found more in fruits vegetables and herbs. Deficiency in any of these minerals in the body can results in one type of disease or the other (Ogboru *et al.*, 2017).

Species Flavouring and Thickeners

Food provides the needed strength and energy as well as preventing diseases and ill-health to the body Addis *et al*., 2005 reported that spices cannot be classified as food for they contain little of nutritive value. They however give an agreeable flavor and aroma to food and greatly to the pleasure of eating. In addition, they excite the appetite and boost the flow of gastric juice due to their roles; they are referred to as "food accessories or adjuncts". They are notable from condiments which are spices or other flavoring substances that have sharp taste and are usually added to food after it had been cooked. Medically, spices are very important as many of them are used as carminatives and antiseptics, spices from our forest are: *Monodora myristica, Xylopia* *athiopica, Tetrapleura teraptera, Pipper gnensis* leaves and seeds), *Dennetia tripetala, Aframonum melegueta, Allium cepa, Zingiber officingle, Curcumalonga cimanonum, Zeylanicum and Frangrance* among others.

Non-timber forest products and household health

It has been said that 80% of total households particularly in the rural areas depend on natural herbs for their health care delivery (Chowdhury *et al.,* 2009). Recent trends have confirmed this observation as the number of people depending on herbs for their health needs keep increasing (Wachtel-Galor & Benzie, 2011). This is due to the worsening economic situation in the country which makes orthodox medicine unaffordable to the rural people. Often times, the distances between rural communities and health care centre are quite considerable hence, rural dwellers naturally rely on traditional herbs when need arises. It is only when the situation gets out of hand that they seek modern medicines, assistance e.g. during complicated child delivery process by women, fatal accidents and prolonged illness (Burkill, 1995).

Plants used as anti-diabetic

Several plants have been identified as having great potentials and ingredients to provide curative measures to some ailment affecting rural people. For example, *Azadirachta indica* (Neem) which is known as the village doctor because of the many medicinal uses to which it is put, is still popular among patients suffering from diabetic mellitus. With the availability of formulated drugs containing 10% Neem, Insulin treated patients are gradually shifted away from dependency on exogenous supply of insulin (Gill, 1992). *A. indica* apart from being used as anti-diabetic, it is also found to be antiseptic and anti-fungi. It is known to have anti-malaria, cardiovascular, nervous and anti fertility properties. Glucolisine and diabetoline were also reported from *Tecoma stans* (Ayodele *et al.,* 2010). Carica papaya used as anti-diabetic in etho-medicine has been reported (Ajoola *et al*.,2011).

Table 1: Selected Plants and their Ethnobotanical Potentials

S/n	Name of plant	Part used	Medicinal use
1.	*Abroma augusta (*Devil cotton*)*	Root bark	emmenagogue agent
2.	*Abrus precatorius (*Jequirity, Indian liquorice*)*	Root, leave	Liquorices substitute expectorant BPC, constipation, snake bite, contraceptive.
3.	*Acacia nilotica(*Bonni)	Bark and leaf	Pile, cures keratoderma, dysentery and diarrhoea
4.	*Acalypha ciliata (*Jiwinni)	Leaf	Ulcer
5.	*Acanthospermum hispidum (*Emu*)*		Jaundice, malaria, ear ache, eye sight
6.	*Achyran these asperlinn (*aboro)	Root	Treatment of scorpion bite
7.	*Adansonia digitata* (Ose)	Leaf	Anaemia, amenorrhea
8.	*Adenia cissampeloides*	Bark	Hypertension and numbness
9.	*Aegle marmelos* Beal fruit	Unripe fruit	Astringent in diarrhea and dysentery
10.	*Aframomum melegueta* (Atare)	Seed	Cancer, cough, anaemia, dysmenorrheal
11.	*Afzelia Africana (*Apa)	Leaf and bark	Cough, hypertension, stomach ache and gonorrhea
12.	*Ageratum conyzoides (*Imi esu)	Leaves	Jaundice, dysentery, diabetes, convulsion, conjunctivitis, Eyes Inflammation, sore throat treatment and female infertility
13.	*Akhornea cordifolia (*Ewe epa)	Leaves	Eyes rheumatism, fever
14.	*Albizia zygia (*Ayunreta)	Bark	Treatment of yaws
15.	*Allophyllus africanus (*Eekan ehoro)	Leaf	Pile, lactation and fecundity
16.	*Alstonia boonei de wild (*Ahun)	Leaves, roots	Snake bite, rheumatism
17.	*Annona comosus*	Fruits juice	Malaria
18.	*Azadirachta indica (*Neem margosa tree)	Leaves, stem, seeds, root bark	Parasitic skin diseases
19.	*Baphia pubescens (*Benin camwood)	Bark	Disinfectant urinary tract
20	*Blighia sapida*	Leaves	Weak penile/ erection
21	*Boerhavia diffusa*	Leaves	Female infertility
22.	*Byrsocarpus coccineus (*Orikoteni)	Leaves, roots	Gonorrhea and jaundice
21.	*Cajanus cajah*	Leaves	Small pox
22.	*Canna bibentata bertolori* (ido)	Juice of unripe fruit leaves	Fever haemostatic
23.	*Carica papaya*	Juice in unripe fruit, leaves	Proteolytic enzyme BPC
24.	*Chenopodium ambosioides*	Fresh plant	Ascaride, hook work
25.	*Cinchona spp (*Quinine bark)	Bark	Tonic, stomachic and malaria
26.	*Cinnamomum zeylanicum*	Leaves, bark	Dental dressing, flavouring agent & powerful germicide

Table 1 cont'd

27.	*Citrus limon*	Fruits/leaves	Abortion/malaria
28.	*Coffae Arabica*	Seed kernel	Cardiac and respirator stimulant
29.	*Cucurbita pepo*	Seed kernel	Ascaride and tapeworm
30.	*Curcuma longa*	Rhizome	Antibiotics
31	*Dacryodes edulis*	Bark / leave	Rashes in body
32	*Daniellia oliveri*	Leaves	Skin disease
33.	*Datura stramonium*	Leaves &seed	Bronchitis & asthma
34	*Derris elliptica*	Roots	Scabies
35.	*Garcinia kola*	Seeds/fruits	Cough/snake bite
36.	*Guphorbia hurta*	Plant	Astmha
37.	*Holarrhera Africana*	Stem-bark	amoebic dysentery
38.	*Melalueca leucadendron*	Fresh leave	Urinary tract, skin disease, rheumatism
39	*Morinda lucida*	Leaves	Treatment of infertility in both men/women and treatment of high sugar in body.
40.	*Musa paradisiacal*	Leaves	Swollen stomach
41.	*Okoubaka aubrevillie*	Fruit, bark, leaves, seed	Sickesses by evil spirits, Rheumatism, malaria fever, convulsion in children, insanity, stroke,asthma,
42	*Pentenclethra macrophylla*	Leaves/fruits	Poison
43	*Piper guinensis*	Seeds	Newly born mother for soup
44.	*Rauwolfia vomitoria*	Bark, roots, leaves, juice	Hypertension
45	*Sacharum officinarium*	Juices	Restoration of vitality
46.	*Sida cordifolice*	Seeds	Migraine
47	*Strychnos nux vomica*	Seeds	Nervous & circulatory stimulant
48.	*Tamarindus indica*	Fruits pulp	Laxative
49	*Telfera occidentalis*	Leaves	Convulsion
50	*Tetrapleura tetraptera*	Fruits	Snake bite
51	*Terminalia catappa (*ebelebo)	Leaves, bark, roots, fruit, seed	Reduces blood sugar, prolongs ejaculation, anaemia, dysentery, coughs, asthma and relieves joint pains
51	*Tridax procumbers*	Leaves	Ulcer & hypertension
52.	*Vemonia amygadalin (*bitter leaf*)*	Leaves, stem, roots	Cough/mouth wash, worm expeller, aphrodisiac,
53.	*Xylopia aethiopica*	Seeds	Dislocation
54.	*Zanthoxylum spp*	Leave/seeds	Abdominal pain, toothache
55.	*Zolanum Torvuly*	Leaves	To Stop Bleeding

Source: PROTA, 2008; Idu, 2009

Conclusion

Medicinal plants represent a reliable fraction of the innate biodiversity bequest of the world. These species offer a vital part to health care delivery, local economy, cultural veracity and ultimately the well-being of the people, particularly the rural communities (women, children and the elderly). Their role has been increasingly acknowledged over the last decade which has brought interest on these medicinal plants. The use of ethno-medicinal information has contributed to health care worldwide, even though efforts to use it have been irregular. It is recommended that government should make research grants available for more studies to be done as regards medicinal plants to discover more flora species of great ethno-botanical potentials. Great public awareness should be introduced of the therapeutic value of herbs and forest.

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Forestry Activities among Communities in Surulere Local Government Area of Oyo State

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Abstract
Assessment of forestry activities was made in some selected villages in Surulere Local Government Area Ogbomoso, Oyo State with the aim of examining the various forestry related activities, benefits derived in engaging in forestry activities and identifying the factors affecting availability of forest products in the study area. The number of respondents selected from each village was based on proportional allocation. A total of 117 questionnaires were retrieved for analysis. Data collected were analysed using simple descriptive statistics. Findings showed that majority (54.7%) of those who participated in forestry related activities were female. Majority (52.1%) also had household number of 1 – 4 and 47.9% had house hold number of 5 – 10. Agro forestry was the major (52.1%) forestry related activity engaged in by the residents of the study area, followed by firewood gathering (22.2%). From the study, food (49.5%) and firewood (24.8%) were the most important benefits derived from the forestry activities. The factors responsible for the availability of these forest products include seasonality (37.6%), transportation (33.3%), legislation (17.1%) and depletion of resources (12.0%). To ensure rural involvement in forestry related activities, it is therefore recommended that rural people should be given rights to access forest resources in the locality where they live, there should be public enlightenment through forestry extension agent on the need to use the resources sustainably and avoid over – exploitation, encourage afforestation and reforestation.
Keywords: Communities, Forest Products, Benefits, Assessment, Livelihood and Involvement

Introduction
Forestry is the skillful management of all natural resources which occur on, and in association with forest lands for greater human benefits. Under good management, a forest should be able to fulfill its key roles to humanity, notably, that of production, protection and recreation (Etukudo, 2000). Rural households are strongly dependents on the services that ecosystems provide such as forest and environmental resources. A large proportion of rural dwellers are dependents on forest and environmental resources for commercial utilization (e.g. Timber and charcoal) and to fulfill subsistence needs for example fuel wood, wild fruits and roots, bush meat and natural medicine (Pantal *et al,* 2009; Howell *et al*, 2010). Forest resources extraction and its related activities also generate employment (e.g. larger timber extraction operations) and support the livestock sector in the form of fodder. In addition, forest helps to regulate the quality and supply of water and provide other ecological services, wild life habitat, biological diversity, soil conservation and carbon sequestration which are essential for human well-being (Pagiola *et al,* 2004). Studies have shown that rural people are involved in forest conservation in many ways, their true roles in forest conservation receive insufficient recognition by policy makers and the participation can be economic and non-economic. Thus, a significant attention has to be paid to the full participation of rural people in forest conservation. However, rural dwellers depend on forest for their livelihood such as sources of food, medicine, raw materials for industries and income for people. Considering these importance of forest to human survival, and roles of people in forest conservation, it is necessary to assess forestry activities in Surulere Local Government Area,Ogbomoso, Oyo State.

Methodology

The study was conducted in some selected villages in Surulere Local Government Area, Ogbomoso, Oyo State. Ogbomoso is located within latitudes $8^0$2' 35.20" N and 8^0 14' 34.25" N and longitudes $4^0$10'52.92" E and $4^0$19' 40.59" E. it is located within a derived savannah region. It is 104km North East of Ibadan, 58km North West of Osogbo, 57km South West of Ilorin and 53km North East of Oyo. The population of Ogbomoso was approximately 299, 535 by 2006 census in Nigeria. Seven communities were purposively selected in Surulere Local Government Area, Ogbomoso, Oyo State (Purposive sampling) being areas where forestry activities are predominant. The number of respondents selected from each community was based on proportional allocation of the people. Hence, 10% of the estimated populations were sampled (table 1). A total of 149 respondents were randomly sampled. Only 117 questionnaires were retrieved for analysis. Data were collected through the use of a well-structured questionnaire. It contains personal characteristics of respondents such as age, (years) sex, (M/F) marital status (single / married / divorced), household size (in number), educational status (primary / secondary / tertiary), forestry activities (such as firewood gathering, logging, agroforestry, hunting) benefits derived in engaging in forestry activities (food, medicine, firewood, charcoal, timber) and factors affecting availability of forest products (Seasonality / transportation / legislation/ depletion of resources).

Date collected were analyzed using simple descriptive statistics such as frequencies, percentages and charts

Table 1: Sampled communities

S/No	Selected Communities	Estimated Population	No of respondents 10%
1	Iresa – Adu	400	40
2	Igbon	210	21
3	Iresa – Apa	150	15
4	Odandan	180	18
5	Itemu	200	20
6	Manyin	250	25
7	Onisalalu	100	10

Source: National Population Commission, 2017

Results and Discussion

Personal characteristics of respondents

Table 2, shows that half of the respondents fall between age ranges of 31 – 40 years; that is, they are within the youthful age and active to struggle for their livelihood. Usman *et al*. (2008) reported that farmers at their youthful ages are more productive and easily adopt agricultural innovations. Majority of the respondents (54.7%) were female while the remaining 45.3% were male. The higher number of female could be as a result of women involvement in agriculture who might want to engage in forestry related activities as a means of livelihood. The majority (51.3%) of the respondents were married. This implies that married men and women were more involved in forestry related activities in the study area. Married people are less likely to use hired labour for the forestry activities since family labour might be employed. Household size results revealed that 52.1% had household size of between 1 – 4 persons while 47.9% had household size of between 5 – 9 persons. Household size determines the availability of family labour, the larger the household size, the more human capital available to the family that can contribute to family farming labour. Table 2 also indicates that 26.5%, 61.5%, and 12% of the respondents acquired primary, secondary and tertiary education respectively. Their literacy level is likely to help in the development of individual mental ability to gain knowledge about a particular concept, understanding and utilization of technology or practice as reported by Mamen and Paxson (2000).

Table 2: Personal characteristics of respondents

Variables	Frequency	Percentage
Sex		
Male	53	45.3
Female	64	54.7
Age		
20 – 30	40	34.2
31 – 40	59	50.4
Above 40	18	15.4
Marital Status		
Single	40	34.2
Married	60	51.3
Widow	17	14.5
Number of household		
1 – 4	61	52.1
5 – 9	56	47.9
Educational Status		
Primary	31	26.5
Secondary	72	61.5
Tertiary	14	12.0

(n = 117)
Source: Field Survey, 2017

Forestry activities and its benefit in the Study Area

Figure 1 revealed that 52.1% of the respondents engaged in agro forestry, 22.2% engaged in firewood gathering and logging while 6.0% engaged in hunting. This result shows that the study area is highly rich in forest resources and people participate in various forest activities. The involvement of the respondents in agro forestry would help to maximize the available land, encourage afforestation, and improve soil fertility and structure thereby making food crop available for the people hence this would also improve the livelihood activities of the respondents (Oboho and Abiola 2010). Firewood gathering is mostly done by the female as it is the primary source of energy accounting for over 90% of the total energy used for domestic purposes in Nigeria. It is consumed mostly by the low income and lower middle income households, as well as by operators of cottage and small scale industries and commercial enterprises such as pottery, hotels, schools and hospitals. This firewood gathering serves as a source of income to majority of rural women (Ijeomah and Aiyeloja, 2010). Involvement in logging makes timber available for different constructions, furniture and electricity poles with due permission from the government for easy accessibility. Only 6.0% were involved in hunting, this could be due to the fact that indiscriminate hunting in the forest is an offence according to forest regulations

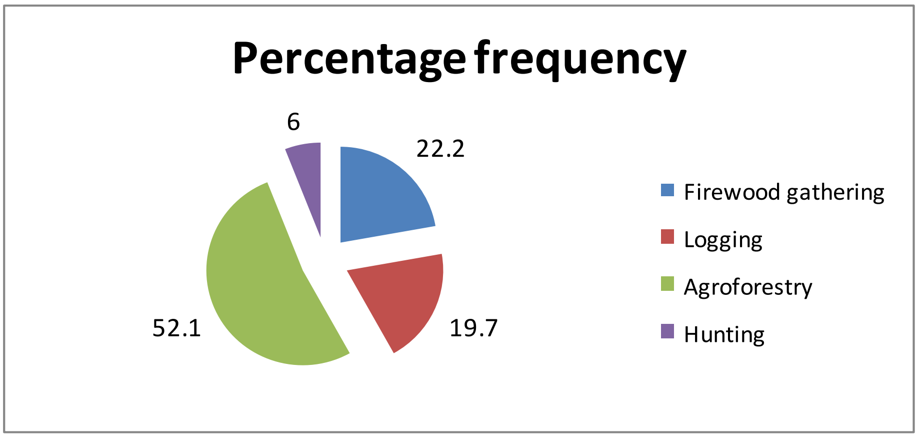

Figure 1: Forestry Related Activities in the Area
Source: Field Survey, 2017.

Factors affecting availability of forest products in the study area

The factors affecting availability of forest products in the study area include seasonality (37.6%), transportation (33.3%), legislation (17.1%) and depletion of resources (12.0%). Seasonality is the most affecting factor. This could be due to the nature of vegetation distribution in which rainfall determines the vegetation growth. Season of the year determines the availability of some forest products. *Anacardium occidentale* (Cashew), *Mangifera indica* are always in abundance towards the end of dry season and onset of rainfall (February – May) particularly in the Southwest part of Nigeria. Medicinal herbs are very abundant during the rainy periods when forests are green for easy identification of the trees, herbs and shrubs. The herbalist and herbal sellers are able to collect them and preserve for use during the dry season. Fuel woods are always readily available during the dry season when dried shrubs, herbs and dead branches are fallen for collection as fuel wood. The consumption of this fuel wood is however concentrated in the rural areas and among low income urban populations (Ijeomah and Aiyeloja, 2010) Transportation challenges could be due to hike in fuel price, and general economic recession. To transport fuel wood and timber products from point of collection to consumption point are sometime costly and difficult for consumers'. Legislation factor affects forest products availability through enacted laws that hindered free entering of the forest. For instance, it is only licensed contractor that has full right to fell approved timber from the forest. Indiscriminate hunting (i.e. Poaching) in the forest is also prohibited so as to conserve wildlife habitats, Kalu (2010). This is why forest guards and National Parks Patrol team protects the forests so as to conserve and preserve the existing natural resources. Depletion of resources arises when forest products are explored excessively or indiscriminately without planning for regeneration by the people. This means that the needs and aspirations of present generations are met at the expense of the future generations in respect of forest goods and services. This will negatively affect the benefit of the forest that the future generation will explore (Kalu, 2010).

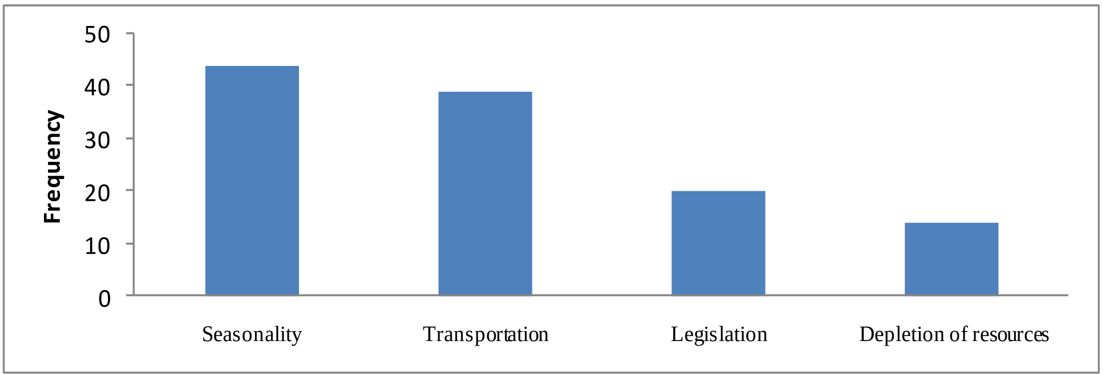

Figure 2: Factors affecting availability of forest products
Source: Field Survey, 2017.

Conclusion

The study has shown that the inhabitants actively involved in forestry related activities such as firewood gathering, logging, agro forestry and hunting. They also rely on forest for food, medicine, firewood, timber and rope. It is therefore concluded that rural people participation in forest related activities will reduce unemployment and poverty and at the same time conserve our environment if judiciously explored. Rural dwellers should therefore be given rights to access forest resources in the locality where they live. They should be enlightened on the need to use the resources sustainably and avoid over – exploitation arising from "a life for today attitude. Government at all levels should encourage people to plant and retain trees of high economic values on their farms

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Environmental Management in Nigeria: Challenges and Way Forward

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Abstract
This paper discusses the challenges of environmental management in Nigeria and the way forward. The paper notes that Sustainable Environmental Management is far from being achieved in Nigeria and that the activities of man still degrade the environment. The major challenges of environmental management in Nigeria include rapid urbanisation, over population, deforestation, desertification, waste management, soil erosion, flooding and poor policies. Overcoming environmental management challenges demands the enhancement of agricultural production without compromising the natural ecosystem, strengthening of local governance for biodiversity, management of environmental resources (land, water, minerals, energy, forest wealth and biodiversity), as well as management and control of hazards. Addressing environmental management challenges requires the role of the government (at national, state and local levels), non-governmental organizations, and community based organizations, as well as individuals. Other environmental management techniques involve the conservation of wildlife, biodiversity, energy, and population resources. There should be respect and care for the environment as well as periodic environmental impact assessment.

Key words: Environmental management, challenges, environmental resources and Nigeria

Introduction
The primordial aim of development in the environment is to improve the quality of life and enable people to realize their potentials and lead lives of dignity and fulfilment. Development is real only if it makes human lives better in all these respects. A development pattern that pays little or no regards to environmental issues is essentially a disaster right from the conceptual framework (Ivbijaro, 2007). Sustainable development therefore, is the development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. Sustainable development is economic and social development that ensures that the environment is conserved to perform its various functions including the functions to humanity. It is development that is pro-people, pro-nature and pro-job (Ivbijaro *et al.,* 2006). Environmental management on the other hand is the process of putting together those items of environmental nature where man exists so that man's penetration and exploitation do not have adverse effect on the environment. This is aimed at ensuring that the environment is free from abuse, and misuse that may result in pollution and degradation. It is aimed to promote development compatibility, balance urban land use value and upgrade the environment for present and future generation (Uchegbu, 1999). In Nigeria, Environmental Management has remained consistently bad over the years and the problem has become a monster that is difficult to solve in spite of all efforts from all arms of government. Consequently, the environment continues to deteriorate while environmental related diseases aggravate poverty (Okueso, 2008). This paper is a review of environmental management in Nigeria – challenges and way-forward.

Challenges to Environmental Management in Nigeria
a. ***Urbanization:*** This is caused by high population growth rate and rural-urban migration. In Nigeria, it is characterized by city slums with serious environmental consequences. The problem is acute and exemplifies the inability of development measures to keep pace with the rate of population growth. Environmental conditions in cities have gradually deteriorated due to the rapid growth of the cities and the attendance inability of social services and

infrastructures to keep pace with the rate of growth (Nigerian Environmental Study Action Team - NEST, 1992).

b. ***Waste management:*** Indiscriminate disposal of wastes is a serious problem in Nigeria. The problem of the disposal of refuse is quite serious because of the rapid rate of generation of non-biodegradable materials, such as plastics. Inadequate storm drains, dumping of refuse in drainage lines and construction of houses close to or even on the natural water channels have been shown to be responsible in that order for the increasing cases of flood in the urban centres (Iboaya, 2000).
c. ***Overpopulation:*** Population is a major factor in all environment-related issues. Overpopulation causes stress on the environment. Environmental problems, such as overpopulation, degradation, erosion, desertification, etc. are caused by man's misuse of environmental resources. There are evidences everywhere of rapid decline in environmental quality and human living conditions by rapid increase in human numbers. Under such stressful situation, "it will be easy for people to become so exigent, worrying only about what to get out of the environment for their own immediate needs and uses, without caring very much for the consequence, especially, for succeeding generations (Abumere, 2002).
d. ***Deforestation:*** Deforestation is a process whereby trees are felled for several purposes, but without replanting to replace the ones felled. Deforestation is dangerous to man, animals and properties. It leads to erosion of the soil and storm, which can cause destruction of properties, crops and animals. When forests are cleared, the soil are exposed to erosion devastation, floods occur, and rivers and lakes are filled up with silt. The water becomes dirty and impure for mankind. The removal of tree canopy (particularly the leaves) has effect on the rainfall of that area, as there is less leaf surface area for the transpiration of water, which in turn affects the relative humidity of the atmosphere. The repeated cultivation of crops on cleared area of plants tends to exhaust the soil of its mineral content. Deforestation in general - for agricultural development, urban growth, industrial expansion and pressure from an increasing population - has reduced the extent, diversity and stability of the Nigerian forest (Iboaya, 2000).
e. ***Desertification:*** Desert is a barren, waterless, treeless and often sand-covered land, such as Sahara, which spreads across Africa continent. Desertification is, therefore, the encroachment of the desert on the land that was once fertile. Desertification can be induced either by natural process or by the action of man. Natural hazards, such as drought and deposit by winds, are prime factors in the desertification process. Desertification is more pronounced in the northern part of the country, where the Saharah desert has eaten deep into the once fertile land (Iboaya, 2000).
f. ***Pollution:*** Environmental pollution can be categorized into three groups. These are air or atmospheric pollution, aquatic or water pollution and land or surface area pollution. The World Health Organization (WHO, 1990) defined air pollution as "limited to situation in which the outer ambient atmosphere contains materials in concentrations which are harmful to man and his environment". Man's activity on the earth surface has largely degraded the quality of the lower atmosphere. The growth and development of industries and urbanization has contributed greatly to the excess carbon monoxide produced by combustion and other human activities. Carbon monoxide reacts with the blood vessel and prevents it from taking up oxygen and the people are suffocated. In Nigeria, several rural towns that had in the past enjoyed fresh and dry air are currently experiencing air pollution problems due to industrialization process and expansion in human activities (Obajimi, 1998).
g. ***Soil Erosion and flooding:*** This problem results from human actions and natural occurrences through the action of erosional agents like excessive rainfall, wind, glacier, steep slopes and poor soils amongst others. The human activities include the construction of engineering projects involving scrubbing, quarrying and the removal of soil materials, over-grazing of green areas, the destruction of vegetation to create space for the growing population, certain mining and industrial activities. Flooding is brought about by the ineffectiveness of the river to flow according to course (such as rivers overflowing their banks) and by heavy rainfall-with poor-water infiltration and poor drainage network (Iboaya, 2000).

Adah and Abok (2013) identified the challenges facing water management in Nigeria to include lack of effective compliance to policies, weak data base, fragmented responsibility, climate change, poor state of infrastructure, cost intensive, corruption, rapid urbanization, and low rate of costs recovery as the bulk of available water supply is unmetered and where metered, ridiculously low rates are charged, the relevant data for the study were sourced from Federal Ministry of Agriculture and Water Resources (FMAWR), UN-Habitat publications, Water Aid, and other relevant paper presentations. The statistics from these sources formed core sources of statistical information. Recommendations were made as the way forward to achieving sustainable water management. There is need for total compliance to water management policies (both local and international), encourage stakeholder participation, enforcement of existing laws and regulatory responsibilities. There is also a great need for management policy that aims at financial viability and economic efficiency. More realistic water rates should be charged in order to raise the much- needed revenue to meet increasing production and distribution costs. Maren, Agontu and Mangai (2013) underscored the dangers of solely depending on oil and gas as the source of energy to every sector of the economy despite the enormous renewable energy potentials in the nation. It also highlights the need for the nation to diversify its energy supply for power stability and energy security as any major breakdown in the sector will result to economic stalemate. It suggests an implementable policy framework that will add renewable energy technology which is clean and sustainable to the nation's energy sector. The study recommended energy availability, accessibility and utilisation has remained inadequate and inefficient as occasioned by the epileptic power supply, constant queues in our filling stations and the folding up of industries in the nation to neighbouring African countries due to insufficient power supply resulting to unemployment.

Way forward to Environmental Management in Nigeria

The Nigerian environment not only plays a vital role in life support system, it particularly provides the basic resources for virtually all socio-economic activities in the country (Nwachuckwu, 2002). Nevertheless, the life support system has been subjected to series of devastations as a result of natural catastrophes and human activities. In order to save the environment from further degradation of the rich and exhaustive resources, it becomes inherent to address the challenges so as to be able to achieve environmental sustainability. Overcoming environmental management challenges demands the enhancement of agricultural production without compromising the natural ecosystem, strengthening of local governance for biodiversity, management of environmental resources (land, water, minerals, energy, forest wealth and biodiversity), as well as management and control of hazards. Other environmental management techniques are the conservation of wildlife, biodiversity, energy, and population resources. Raven, Berg and Hassenshall (2010) submitted that the elements that contribute to addressing environmental problems include scientific assessment, risk analysis, public education and involvement, political action and long term evaluation. However, they opined that solving environmental problems rarely proceeds in such a straight forward steps. Nevertheless, the five stages represent an ideal approach to systematically address environmental problems. Subsidiaries of this approach include the conservation of natural resources, pollution abatement, control of bush fires, planned industrial development, evaluation and monitoring of radioactivity, as well as resource sharing. Addressing environmental challenges requires the role of the government (at national, state and local levels), non-governmental organizations, and community based organizations, as well as individuals. It also necessitates the collaborative efforts of international organizations, law enforcement agencies, academics and technocrats, the youth, the press as well as national and multi-national companies. Hazard control process is concerned with recognizing, evaluating and eliminating/mitigating hazards that occur because of human errors and physical deficiencies in the environment (Jain and Rao, 2011). Natural events cannot be prevented from occurring but their impacts can be reduced if effective measures are taken in order to depress their severity, frequency and impacts. Strategies of mitigating the effects and/or coping with the impacts of natural challenges include proper and sound environmental education, environmental monitoring with the use of satellites, geographical information systems and remote sensing techniques, government legislations, reintroduction of species, disaster forecasting and mitigation, as well as environmental risk assessment and mapping. On the other hand, the management of man-induced challenges requires poverty alleviation, control of population growth, recycling of materials and resources, reduction of arms race, as well as women empowerment. The mitigation of anthropogenic challenges has to do with the type, cause(s), and consequences. For instance, curtailing man-induced desertification requires measures like irrigation farming, agro-forestry, rotational grazing, and prevention of illegal felling of trees, controlled use of wood as source of fuel and energy, as well as afforestation and re-afforestation programmes. Also, man-influenced flooding can be controlled through channelization and regular clearance of drainage channels, urban planning, sustainable waste management, as well as environmental sanitation. In like manner, control of soil erosion takes the form of cover cropping, contour ploughing, controlled grazing, terracing, and creation of shelter belts. In all, disaster management is all encompassing. It entails respect and care for the environment as well as periodic environmental impact assessment.

Conclusion

When man assumes a non-challant attitude towards his environment, neglecting the need for conservation in the environment, his actions will not only affect the present life, but will put the environment in jeopardy for the future generation. It is essential therefore, to know that a neglected environment stands to attract hazards. Hence the need for environmental management. Environmental management thus, is the strategy by which human activities that affect the environment are organized with a view to maximizing social well-being and to preventing potential problems by addressing their root causes. Also appropriate environmental management can be achieved through efficient use of resources for the benefit of human development. Environmental protection techniques need to be cultured, home-grown and the framework should be “Bottom – Up”. It should be community based. The framework should be organized at the village or community level. Addressing environmental challenges requires the role of the government (at national, state and local levels), non-governmental organizations, and community based organizations, as well as individuals.

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Soil Conservation Practices for Food Security in Nigeria

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Abstract
This paper is a review of soil conservation practices for food security in Nigeria. Soil conservation is a practical agro-ecological approach to achieving sustainable agriculture intensification. It offers environmental, economic and social advantages as well as improved productivity and resilience, and improved ecosystem services while minimizing the excessive use of agrochemicals, energy and heavy machinery. The paper identified indigenous soil conservation practices as focused on soil and water conservation by ridging, constructing earth bunds and terraces, mulching, multiple cropping, fallowing, and tree planting. According to the literature, soil conservation measures should be site-specific depending on the local factors such as topography, soil texture, water regime, and farming system. Mulching, crop management, and conservation tillage are appropriate technologies for conserving sandy soils of high erosivity and low water-holding capacity in Nigeria.
Keywords: Soil conservation, practices, crop management and improved productivity

Introduction
One of the most severe threats to food security in Nigeria is declining productivity as a result of the loss of soil fertility. Soils in Nigeria suffer deficiency common to the soils in the tropic such as a low percentage organic matter and nitrogen, shallow depth and high acidity which predispose about 63% of agricultural soils in Nigeria to low productivity. Soil conservation is a combination of all methods of management and land use that safeguard the soil against depletion or deterioration by natural or man-induced factors (Lekwa and Whiteside, 1996). According to Food and Agriculture Organization of the United Nations (FAO, 2013), one of the main causes of soil degradation identified in various parts of Africa is the practice of inappropriate methods of soil preparation and tillage. The soil naturally replenishes itself when used properly. In an attempt to maintain optimum crop productivity, farmers are encouraged to adopt different production technologies that would conserve the soil. In relation to this, Onwudike *et al.* (2016) suggested adoption of many strategies will eventually result at improving soil productivity and crop yield.
Research on soil conservation has been conducted for many years in Nigeria. Initiatives have resulted in various so-called on-farm strategies including agronomic measures, soil management, and mechanical methods, as well as off-farm strategies, including mechanical or biological soil conservation technologies. This paper provides a review on soil conservation practices for food security in Nigeria.

History of Soil Conservation in Nigeria
In Sub-Sahara Africa, soil conservation has a long tradition. Indigenous techniques from the pre-colonial era focused on erosion control in combination with water conservation by ridging, mulching, constructing earth bunds and terraces, multiple cropping, fallowing, and the planting of trees (Igbokwe, 1996). In colonial times, the British Government worked on natural resource management as interest was high in expanding commercial farming enterprises. Longtau *et al.* (2002) recorded the implementation of terraces in several areas on the Jos Plateau in former times. Large-scale projects on soil loss control were started, especially in areas of high agricultural potential, but many of them failed as the imported technologies had little relevance in the tropics and were not adopted later by local farmers. After independence in 1960, more emphasis was put on soil fertility issues. Decrease in funds at the end of the oil boom in the 1980s

additionally restricted the performance of soil conservation schemes in Nigeria (Slaymaker and Blench, 2002). Today, the seriousness of this environmental problem still exists and is also recognized by the Federal Government of Nigeria that planned to spend about half a million US dollars on soil erosion projects all over the country in 2007 (Federal Government of Nigeria, 2007).

Agronomic Measures for Soil Conservation in Nigeria

Agronomic measures include - mulching and crop management, the use of the effect of surface covers to reduce erosion by water and wind (Morgan 1995).

a. Mulching

Mulch is a layer of dissimilar material placed between the soil surface and the atmosphere. Different types of material such as residues from the previous crop, brought-in mulch including grass, perennial shrubs, farmyard manure, compost, by-products of agro-based industries, or inorganic materials and synthetic products can be used for mulching (Lal, 1990). The impact of mulch in reducing the splash effect of the rain, decreasing the velocity of runoff, and hence reducing the amount of soil loss has been demonstrated in many field experiments conducted on several Nigerian research stations. Lal (1993) measured soil loss of about 152.9 t ha^{-1} from a plot with bare fallow and 0.2 t ha^{-1} from a plot with maize and mulch. Salako_*et al.* (2006) compared the effect of burned residues with mulched residues from *Mucuna_pruriens_*and *Pueraria_phaseoloides*. They recorded that soil loss from plots with burned residues of *M. pruriens_*were significantly higher (6 and 2.8 t ha^{-1}) than from plots with mulched residues of *M. pruriens_*and *P. phaseoloides_*(1.5 and 1.3 t ha^{-1}) in 1997. *M. pruriens_*was more effective in minimizing the detachment of soil from mounds due to its faster establishment rate, but finally *P. phaseoloides_*was more reliable for soil and water conservation as it produced more mulch. The complete removal of crop residues from the field for use as animal fodder, firewood, or as construction material is another factor that makes this soil conservation technology less applicable (Kirchhof and Odunze, 2003).

b. Crop Management

Soil loss can also be prevented or reduced by appropriate crop management.

- ***Cover Crops:*** Cover crops such as the legumes *P. phaseoloides, M. pruriens, Centrosema_pubescens, Stylosanthes_guianensis,* and *Phaseolus_aconitifolius* or the grasses *Pennisetum_purpureum, Brachiaria_ruziziensis,* and *Paspalum_notatum_*are plants that grow rapidly and close (Lal, 1995). Their dense canopy prevents rain drops from detaching soil particles and this keeps soil loss to tolerable limits, so cover crops play an important role in soil conservation. Cover crops also positively influence physical soil properties. They increase the organic matter content, nitrogen (N) levels by the use of N_2-fixing legumes, the cation exchange capacity, and hence crop yields. Tian_*et al.* (1999) estimated an amount of 84 to 202 kg N ha^{-1} fixed by P. phaseoloides within 18 months. This resulted in a higher maize grain yield (2.5 t ha^{-1}) than in the control without a legume (1.3 t ha^{-1}). Another benefit of cover crops is the suppression of weeds, such as spear grass (*Imperata_cylindrica*) or witch weed (*Striga_hermonthica*) which is common in Nigeria (Ekeleme_*et al.,* 2003).
- ***Improved Fallows:*** Improved fallows of short periods with selected tree or herbaceous species remain important as the long fallow periods that were part of the traditional shifting cultivation system for encouraging soil regeneration are no longer possible in most Nigerian locations. Shrubs of woody plants such as pigeon pea (*Cajanus_cajan*) are advantageous in improving the physical soil conditions due to the penetration of their rootlets into deeper soil layers (Salako and Kirchhof, 2003).
- ***Multiple Cropping:*** Multiple cropping involves different kinds of systems depending on the temporal and spatial arrangement of different crops on the same field (Morgan, 1995). It has been traditionally practiced and is still very common in Nigeria.
- ***Intercropping:*** Intercropping systems including different kinds of annual crops planted in alternating rows also reduce soil erosion risk by providing better canopy cover than sole crops (Morgan, 1995). Odunze_*et al.* (2004) determined the effect of grain legumes in legume/cereal treatments on soil properties in the arid ecosystem of northern Nigeria. The results showed that sole groundnut improved soil bulk density at the 0 to 10 cm depth (1.26g cm^{-3}) better than sole maize (1.34 g cm^{-3}). The cultivation of legumes also resulted in

better stability of soil aggregates in the topsoil, which generally reduces the erodibility of the soil. The highest mean weight diameter of peds developed was 0.63 mm obtained under soybean (*Glycine max*), followed by cowpea (0.58 mm), and sole maize (0.48 mm). Sole legumes and legume/maize treatments improved the soil nitrogen content (range between 65.6 and 84.8%) compared to sole maize treatments (5.9%).

- ***Planting Pattern/Time:*** Planting pattern, plant density, and time of planting also play an important role in soil conservation. Crops planted at close spacing or at a certain time provide a higher canopy during periods with high rainfall intensities and hence protect the soil from erosion. Carsky_*et al.* (2001) recommended cowpea-maize intercropping system as a relatively productive low-input system for the savannah zone. Special knowledge on the selection of species and good crop management is needed when annual crops are planted between hedgerows of woody perennials and this makes alley cropping less attractive for farmers.

Soil Management Practices

Conservation Tillage

Conservation tillage describes the method of seedbed preparation that includes the presence of residue mulch and an increase in surface roughness as key criteria. The practices therefore range from reduced or no-till to more intensive tillage depending on several factors, such as climate, soil properties, crop characteristics, and socio-economic factors (Lal, 1990).

- ***Minimum Tillage:*** Minimum tillage describes a practice where soil preparation is reduced to the minimum necessary for crop production and where 15% to 25% of residues remain on the soil surface (Morgan, 1995).
- ***No-Till:*** No-till or zero-tillage is characterized by the elimination of all mechanical seed bed preparation except for the opening of a narrow strip or hole in the ground for seed placement. The surface of the soil is covered by crop residue mulch or killed sod (Lal, 1993).
- ***Ridge Tillage and Ridge Tying:*** Ridge tillage is the practice of planting or seeding crops in rows on the top, along both sides or in the furrows between the ridges which are prepared at the beginning of every cropping season. Tied ridging or furrow diking includes the construction of additional cross-ties in the furrows between neighbouring contour ridges (Lal, 1990).

Most smallholders in Nigeria still perform soil preparation manually by using hoes. Larger farms use plows and harrows pulled by tractors, which results in the complete inversion of the top 20 to 30 cm of the soil. Hence, ridging is very common all over Nigeria, whereas tied ridging is primarily conducted in the semi-arid northern part of the country to conserve both soil and water in individual basins (Chiroma_*et al.,* 2006).

Mechanical Methods

Mechanical methods, including bunds, terraces, waterways, and structures such as vegetative barriers or stone lines installed on farm also can break the force of winds or decrease the velocity of runoff to reduce soil erosion (Morgan, 1995).

- ***Terraces***: Contour bunds made of earth or stones or terraces that consist of an excavated channel and a bank or ridge on the downhill side for cultivating crops are permanent erosion control technologies (Morgan, 1995). Field trials on terraces made by Lal (1995) in Ibadan showed that the mean soil loss from a catchment without any erosion control measures was 2.3 t ha^{-1} and from a terraced catchment 0.7 t ha^{-1}.
- ***Waterways***: Waterways such as cut-off drainage are permanent structures that aim to collect and guide excess runoff to suitable disposal points. They are constructed along the slope, often covered with grass to prevent destruction, and primarily installed in areas with high rainfall rates (Morgan, 1995). The implementation probably needs special knowledge of the water regime of the area and the construction of waterways (Lal, 1995).
- ***Structures:*** Structural barriers made of stones or vegetation installed along contour lines are another mechanical erosion control measure (Morgan, 1995). As they operate as filters, they may not reduce the runoff amount but retard its velocity and hence encourage sedimentation, increase infiltration, and facilitate the formation of natural terraces (Lal, 1990). Vegetative barriers are usually constructed as single lines or in the form of strips of several meters wide. Malgwi (1995) investigated the effectiveness of vetiver (*Vetiver_zizanioides*), a perennial grass

with a deep and fibrous root system, in northern Nigeria. He recommends this grass as an appropriate soil conservation technology for semi-arid zones as it also withstands denudation, fire, drought and flood.

Future Prospects of Soil Conservation

According to World Bank (2012) and Kassam_*et al.* (2014), there are several ways to support immediate and wide spread scaling up of soil conservation:

- Develop and implement enabling government policy and programme initiatives by encouraging and strengthening government capacity to update agricultural policies, reform perverse commodity support programmes, and institute policy reform that supports the up-scaling of conservation agriculture (i.e. soil conservation) in Nigeria.
- Develop and implement an enabling policy environment for private sector participation in development and support for promotion of soil conservation.
- In all new agriculture development projects, include conservation agriculture as the basis for sustainable production intensification and engage all relevant stakeholders to ensure success, including creating an enabling environment for private sector participation.
- Advocate for initial government support in terms of incentives to make appropriate farm equipment more readily accessible and to reduce any risks of possible productivity loss during the initial years of switching to conservation agriculture.
- Develop large scale programmes that would offer payments to conservation agriculture farmers for harnessing ecosystem services such as carbon sequestration, watershed services for increasing the quality and quantity of water resources, control of soil erosion and reduction in flood risks, and sustaining pollination services.
- Revise universities' agriculture curricula to include teaching the next generation of farmers and agricultural development practitioners about soil conservation as an alternative and sustainable way of farming.
- Provide agricultural universities and schools with relevant literature and publications about CA in the local language.
- Fund more innovative practical research to tackle soil, agronomic and livestock husbandry challenges through universities and research centres.

Conclusion

This paper is a review on soil conservation practices for food security in Nigeria. Indigenous soil conservation strategies focus on soil and water conservation by ridging, constructing earth bunds and terraces, mulching, multiple cropping, fallowing, and tree planting. According to the literature, soil conservation measures should be site-specific depending on the local factors such as topography, soil texture, water regime, and farming system. Mulching, crop management, and conservation tillage are appropriate technologies for conserving sandy soils of high erosivity and low water-holding capacity. Leguminous cover crops and residue management reduce the impact of rain, which is especially high in the tropics, and trap and store soil moisture. These measures also enhance the levels of soil organic matter and nutrients, especially nitrogen, which is generally limited in tropical soils. The future of soil conservation requires that farming and agricultural landscapes are multi-functional, ecologically sustainable and integrated into the greater ecosystems alongside non-agricultural land uses. This means that agricultural production enhancement must go hand in hand with the enhancement and delivery of desired ecosystem services, and that production systems must be efficient with high production factor and resilient in on-farm performance and socio-economic development.

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Environmental Standards and Permissible Limit for "Heavy Metals" in Plants, Soil and Water

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Abstract
Environmental standards and permissible limits are set to check and control the release of contaminants into the environment. Many of these chemicals released into the environment contain metals that are toxic even at low concentrations. These toxic metals generically referred to as "Heavy Metals' have become an interesting subject of study by many researchers. The effects of heavy metals are evident in terrestrial and aquatic habitats affecting soil, water, and health of biological organisms. Obtaining standards and permissible limits for heavy metals in soil, plants and water by researchers is not often easy. It is on this premise that this paper compiles permissible limits for heavy metals that are commonly studied as a reference for drawing conclusions and inferences.

Introduction
Human activities generate substances that can contaminate and pollute one or more environmental compartments. To protect the environment and prevent adverse health problems, it becomes pertinent to regulate the amount of organic and inorganic substances released into environment by way of regulation and setting of standard. Organizations such as Food and Agriculture Organization (FAO) and World Health Organization (WHO) set standards which are accepted globally and are most times used by countries to set their own permissible limits considering their uniqueness and peculiarities. In Nigeria, the National Environmental Standards and Regulations Enforcement Agency (NESREA) is saddled with the responsibility of setting environmental standards and implementing these standards in union with other relevant stakeholders. Many researchers carry out studies involving heavy metals but one major problem has been getting standards upon which they can be able to discuss and classify their findings. This work is a compilation of major heavy metals that are usually studied and permissible limits for each in soil, plants and water.

Concept of heavy metals
Heavy metals are difficult to describe using the most common criteria of specific weight. According to Duffus (2002), 13 different references were cited where the lower limit in density of a metal categorizing them as heavy metal ranged from 3.5 to 7 g cm^{-3}. It was therefore concluded that as a result of not reaching a consensus, any idea of defining heavy metals on the basis of density must be abandoned as yielding nothing but confusion. According to Appenroth (2010) since neither physical nor chemical properties could be effectively used to describe heavy metals especially as it concerns plant sciences, it is suggested that heavy metals be defined by the following groups of the periodic table of elements. Thus, heavy metals refers to all transition elements, except La and Ac (Transition metals); Rare earth elements, subdivided in the series of lanthanides and the series of actinides including La and Ac themselves (Rare earth metals) and heterogenous group of elements including the metal Bi, the amphoterous oxides forming elements Al, Ga, In, Tl, Sn, Pb, Sb and Po, and the metalloids Ge, As and Te (Lead-group elements).

Sources of heavy metals
Heavy metals enter the environment through natural and anthropogenic sources. Natural sources include parent materials, volcanoes and ores. Anthropogenic sources are associated with human

activities such as waste disposal and incineration, industrial effluents, inorganic fertilizers, pesticides, mining, transport emissions, power generation, electronics, batteries, paints, rubber, metal plating, scientific instruments, hospital waste, crude and oil spills. Sources of heavy metals have been documented by Wuana and Okieimen (2011) and Roozbahani *et al* (2015)

Effect of heavy metals on Different environmental compartments

Studies in heavy metals are important because of they have far reaching implications for soil, water, plants and health. Heavy metal is caused various metals, especially Cu, Ni, Cd, Zn, Cr and Pb (Karaca *et al.*, 2010). Some heavy metals (like Fe, Zn, Ca and Mg) have been reported to be of bio-importance to man and their daily medicinal and dietary allowances had been recommended. However, some others (like As, Cd, Pb, and methylated forms of Hg) have been reported to have no known bio-importance in human biochemistry and physiology and consumption even at very low concentrations can be toxic (Duruibe *et al.,* 2007).

Heavy metals exert toxic effects on soil microorganism, changing diversity, population size and overall activity of the soil microbial communities (Ashraf and Ali, 2007). They are also known to affect vital plant processes such as photosynthesis (Bhattacharyya *et al.*, 2008). The consumption of heavy metal contaminated food can seriously deplete some essential nutrients in the body that are further responsible for decreasing immunological defenses, disabilities associated with malnutrition and high prevalence of upper gastrointestinal cancer (Khan *et al.,* 2008). Runoff containing heavy metals enter aquatic environment with potential toxicity for aquatic plants and animals (Singh and Kalamdhad, 2011). Contamination of a river with heavy metals may cause devastating effects on the ecological balance of the aquatic environment, and the diversity of aquatic organisms becomes limited with the extent of contamination (Ayandiran *et al.,* 2009). Heavy metals released into aquatic systems are generally bound to particulate matter, which eventually settle down and become incorporated into sediments. These pollutants can be taken up by rooted aquatic macrophytes and other aquatic organisms (Peng *et al.*, 2008). Drinking water contaminated with high level of heavy metals may lead to health problems such as blood shortage, abdominal pains, nausea, diarrhea, headache, dizziness and liver cirrhosis (Iqbal *et al.,* 2011; Chinedu *et al.,* 2011). Other effect of heavy metals on health, soil, plants and water have been documented by Mahurpawar (2015) and Singh and Kalamdhad (2011).

Table 1: Maximum allowable limit for concentration of heavy metals in soil

Country	Heavy metal in soil (mg/kg)									Reference(s)
	As	Pb	Hg	Cd	Cr	Cu	Zn	Co	Ni	
Tanzania	1	200	2	1	100	200	150	n.a	100	He *et al* (2015)
Nigeria	n.a	n.a	n.a	3.0	n.a	75	350	n,a	n.a	Mohammed & Folorunsho (2015)
China	30	50	0.7	0.5	200	100	250	n.a	50	EPMC (2015)
South Africa	5.8	20	0.93	7.5	6.5	16	240	300	91	Kamunda *et al* (2016)
Canada	20	200	0.5	3	250	150	500	n.a	100	Kamunda *et al* (2016)
Taiwan	60	300	2	5	250	200	600	n.a	200	Lee and Lee (2011)
Bulgaria	10	26	0.03	0.4	65	34	88	20	46	Atanassov (2007)
Germany	50	70	0.5	1.0	60	40	150	n.a	50	Lee and Lee (2011)
USA	n.a	300	n.a	3.0	400	200	250	n.a	n.a	Hong *et al* (2014)
UK	32	70	10	10	6.4	63	200	n.a	130	Hong *et al (*2014)
Poland	n.a	100	n.a	3	100	100	300	50	100	Mtunzi *et al* (2015)
FAO/WHO	20	100	n.a	3	100	100	300	50	50	Chiroma *et al* (2014)
EU	n.a	300	n.a	3	150	140	300	n.a	75	Kamunda *et al* (2016)

Table 2: Permissible limits for heavy metals in plants

Heavy Metal	Limit (mg/kg)	Reference(s)
Nickel	10	Nazir *et al* (2015)
Chromium	1.30	Nazir *et al* (2015)
Cadmium	0.02	Nazir *et al* (2015)
Copper	10	Zigham *et al* (2012)
Zinc	50	Afzal *et al* (2013)
Iron	20	Afzal *et al* (2013)
Lead	2	Nazir *et al* (2015)

Table 3: Permissible limits for heavy metals in open waters

	Heavy metal (mg/l)									Reference(s)
	As	Pb	Fe	Cd	Cr	Cu	Zn	Mn	Ni	
Nigeria	0.5	1.0	1.0	1.8	2	2-4	5	0.1	0.1	Aremu *et al* (2010)
WHO	n.a	0.05	1.0	3.0	0.1	2	5	n,a	0.2	Ni, Cr, Cu (Zigham *et al.,* 2012); Cd, Zn, Pb (Nazir *et al.,* 2015); Fe (Patel and Ahmad, 2011)
USEPA	0.05	0.15	0.3	0.005	0.10	1.0	2.0	0.05	0.05	Aremu *et al* (2010); USEPA (2002)

Table 4: Maximum Allowable Limits for heavy metals in drinking water

Metal	Limit (mg/l)
Lead	0.01mg/l
Arsenic	0.01mg/l
Selenium	Not available
Chromium	0.05mg/l
Cadmium	0.003mg/l
Copper	1mg/l
Manganese	0.2mg/l
Iron	0.3mg/l
Magnesium	0.20mg/l
Mercury	0.001mg/l
Zinc	3mg/l
Nickel	0.02mg/l

Nigerian Industrial Standard (2007)

Conclusion

Environmental standards are set to protect the environment and prevent degradation and adverse health effects. Permissible limits have been set by global organizations like the World Health Organization, European Union, United States Environmental Protection Agency and various countries. Environmental standards and limits differ from country to country depending on environmental peculiarities, best available technology, best practicable technology or best available technology not entailing excessive cost. Efforts are made to ensure that the environment is protected and contaminants kept within permissible limits so as not to cause harm to the environment.

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Status of Beekeeping in Nsukka Local Government Area of Enugu State, Nigeria

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Abstract
The study was conducted in Nsukka Local Government Area (LGA) of Enugu State, Nigeria. The aim of this research was to ascertain the production system and constraints of beekeeping. A total of 60 respondents were selected from the LGA under study. Primary and secondary data were used for the analysis. Data were analysed by using descriptive statistics. The result revealed that beekeeping in this area is practiced by males. Farmers in this area practice traditional beekeeping method, which restrain female participation. The major hindrances to beekeeping are absconding of bees, lack of fund and inadequate market information. This paper recommends adoption of modern beekeeping to encourage female involvement. Also recommended is provision of financial support and market information to bee farmer to advance beekeeping in Nsukka.

Introduction
The unpredictable climatic conditions are increasingly affecting livestock and crop production. Beekeeping is a livelihood option for communities who have depended mainly on production and marketing of crops and animals. The government of Nigeria, in its strategy for development of agriculture, has identified beekeeping and honey production as one of the few means by which people can earn a living without damaging the environment they depend on for survival. Beekeeping is a lucrative agricultural business for rural areas in developing countries (Kukonza, 2009). Beekeeping is the art of managing honeybees primarily for honey production. Honeybees provide honey which has great nutritional and economic values; it also enhances seed production through pollination (Klein *et al.*, 2007). Beekeeping requires little capital and less land space. Soil conditions (such as soil fertility and good drainage) are not essential in beekeeping. Therefore, beekeeping is an appropriate farming alternative in the south-eastern part of Nigeria, which is considered a low soil nutrient area. Eighty percent of Nigeria consists of arid and semi-arid lands, which have high potential for the production of honey and other bee products. However, only one fifth of this potential is being exploited. Many communities in the country use traditional production systems (for example, log hives) which are labour intensive and dangerous (Cramb, 2003); this has made the management of bees difficult. Beekeeping using the indigenous technique is less economically viable (the focus is mainly on honey, with no attention to other bee products such as beeswax, propolis and others).Traditional beekeeping in Nigeria is mainly males' occupation and unsuitable for women because harvesting of honey is mainly done at night and sometimes involves climbing of trees. Low priority is given to modern beekeeping in Nigeria; this has affected the scale of production and productivity of beekeeping. Gok (2004) reported that limited value addition is achieved due to minimal investment in technological and market development initiatives. Consequently, it is necessary to explore ways to encourage technological innovation in the honeybee sector as a means of alleviating rural poverty. Popularizing modern beekeeping enterprise in Nigeria, especially among women, will enhance productivity and improve farmers' livelihood. The objectives of this work were to assess the current status of beekeeping in Nsukka LGA of Enugu State and ascertain the constraints to beekeeping in the LGA. This study will encourage the adoption of modern beekeeping in the study area and also contribute to the existing knowledge on beekeeping in Nigeria.

Methodology

The study was carried out in Nsukka LGA of Enugu State of Nigeria. The State is situated in the south-east geographical zone of Nigeria. It shares boarder with Abia and Imo in the south, Ebonyi in the east, Benue in the north-east, Kogi in the north -west and Anambra State in the west. It has an area of 8,730km^2. The State is densely populated, and is rated at 460/km2 (1,200/sq mi).This is regarded as one of the highest in Africa. Agriculture is the main occupation of the people. It provides employment and income for more than 70% of the populace. There is a total of seventeen LGA in the State. Primary and secondary data were used for this study. Primary data were obtained from farmers by using questionnaire, interview schedule, and direct observation. Secondary data were gathered from various sources such as reports of governmental and non-governmental organization and relevant literatures. Three villages were randomly selected from the LGA. The villages selected include Ibagwa,Ede Oballa and Ibagwani. Farmers were randomly selected from each village making a total of 60 respondents. Data were analyzed with descriptive statistics such as percentages and Tables.

Results and Discussion

Socioeconomic profile of the respondents

Table 1 presents the socioeconomic characteristics of the respondents in the study area. The mean age of beekeepers was 53years. The respondents were mostly middle-aged; youth are yet to be fully involved in beekeeping in the study area. According to the report by new Agriculturalist (2011), the world has more than 1 billion young people aged between 18-30 years, majority among them are unable to fulfil their potential and lack the skills needed to gain employment because of poverty and lack of education. However, given support and the opportunity of employment, young people can play a significant role in rural development. The mean household size was 8 members. Most of the respondents were men (80%); considering the fact that traditional beekeeping is tedious, especially in log construction and bee honey harvesting activities (Cramb, 2003). The Table also indicates that majority of the respondents had primary education, which means that they are not highly educated. This could be one of the reasons for the practice of traditional method of beekeeping, otherwise known as 'honey hunting'. Table 1 also indicates that all the respondents (100%) practice traditional beekeeping, which involves the use of logs and pots for beekeeping. In the traditional system, bees are harvested by setting the colony on fire.

Table 1: Socioeconomic characteristics of the respondents

Variable	Percentage	Average
Age		
20-39	20	
40-59	42	53
60-above	38	
Total	100	
Educational background		
No formal education	25	
Primary	30	8
Secondary	29	
Tertiary	16	
Total	100	
Household size		8
Gender		
Male	80	
Female	20	
Total	100	
Beekeeping Method		
Modern	0	
Traditional	100	

Source: Field survey, 2012

Economic activities of beekeepers in Nsukka Local Government Area

The economic activities of the respondents by gender are shown in Table 2. A higher percentage of women in the area under study were not formally employed, but were more engaged in business and crop farming than men. From the Table, it is clear that men (34%) owned more livestock. Men were more involved in beekeeping than female. Although the traditional beekeeping is strenuous and considered as a male occupation, female were involved in the traditional beekeeping. There is no strong cultural taboo that prohibits women from undertaking beekeeping activities. Equipping women with more skills on lucrative activities like modern beekeeping practice will enable them earn income and hence improve their living standard.

Table 2: Economic activities of the respondents by gender

Economic activity	Women (%)	Men (%)
Formal employment	9	12
Business	34	13
Livestock farming	22	30
Crop farming	25	20
Beekeeping	10	15
Social worker	0	5
Hired labourer	0	5
Total	100	100

Source: Field survey, 2012

Gender roles in beekeeping

With respect to bee keeping activities (Table 2), women (50%) are mostly involved in honey extraction; while, men (46% and 25% respectively) partake more in honey harvesting and traditional bee hive construction.

Table 3: Roles in beekeeping activities by gender

Economic activity	Women (%)	Men (%)
Traditional Bee hive construction	15	25
Honey harvesting	15	46
Honey extraction	50	13
Packaging/sales	20	16
Total	**100**	**100**

Source: Field survey, 2012.

Constraints to beekeeping in the study area

The prevailing production constraints in the beekeeping sub sector of the country vary depending on the agro ecology of the areas where the activities is carried out (Edessa, 2002). Variations of production constraints also depends on socioeconomic conditions, cultural practices, climate (seasons of the year) and behaviours of the bees. Table 4 highlights the major constraints faced by respondents in the beekeeping activity in the study area. Absconding of bees (80%) is the major challenge faced by the beekeepers in this area. This is followed by lack of fund (73%) and inadequate marketing information (70%). Other constraints identified include aggressiveness (65%); lack of better beekeeping technologies (55%); deforestation (48%); lack of extension services (45%) and pest and disease (40%).

Table 4: Major constraints to beekeeping

Constraints	*% respondents
Absconding of bees	80
Lack of fund	73
Inadequate marketing information	70
Aggressiveness	65
Lack of better technologies	55
Deforestation	48
Lack of extension services	45
Pest and disease	40

Source: Field survey, 2012

Note:* The sum of constraints exceeded one hundred due to multiple responses

Sources of Information

Table 5 shows the farmers major sources of agricultural information. A large percentage of the respondents (46.6%) indicated fellow farmers as their main source of information, followed by radio (31%), chiefs (traditional leaders) (6.9%), television (5.2%); Newspapers (3.4%) and extension agents (1.7%) as the least source of information.

Table 5: Farmers Sources of information

Sources of information	Fellow farmers	Radio	chiefs	Television	News papers	Extension agents
% respondents	46.6%	31%	6.9%	5.2%	3.4%	1.7%

Source: Field survey, 2012

Conclusion

The investigation reveals that beekeeping in Nsukka is dominated by middle-aged male with little or no education. They practice traditional beekeeping which is mostly constrained by absconding of bees, lack of fund and inadequate market information. Beekeepers in Nigeria obtain information mainly from fellow farmers. Embracing modern beekeeping will encourage female participation in beekeeping; it will also ensure food security and improve the living standard of farmers. Access to fund and marketing information will enhance the adoption of modern beekeeping Nsukka LGA.

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Comparative Growth, Development and Yield of Rubber in a Rubber Based Cropping System

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Abstract
This study evaluated the effect of rubber-based cropping systems on the development and yields of rubber, maize and cassava was carried out at the Rubber Research Institute of Nigeria, Iyanomo, Benin City. There were eleven treatments (rubber + natural vegetation (Control), rubber + Puereria phaseoloides, rubber + maize (0.25 x 0.75 m), rubber + maize (0.50 x 0.75 m), rubber + maize (0.60 x 0.90 m), rubber + cassava (0.50 x 1.0 m), rubber + cassava (1.0 x 1.0 m), rubber + cassava (1.5 x 1.0 m), rubber + maize + cassava (0.25 x 0.75 m/0.75 x 1.0 m), rubber + maize + cassava (0.50 x 0.75 m/1.0 x 1.0 m) and rubber + maize + cassava (0.60 x 0.90 m/1.5 x 1.0 m), organized in RCBD with each treatment replicated three times. Data were generated on the physico-chemical properties of the soil, development and yields of; rubber saplings, maize and cassava. Rubber sapling biomass was determined in lieu rubber yields. The results showed no significant changes in physico-chemical properties of the soils compared with values before cropping except for available– P, where rubber cropping systems resulted in increased P from pre-cropping values. The highest P values were recorded in the Rubber + maize (0.25 x 0.75 m). Significant increases in the ECEC of the soil were recorded in all the intercropped plots. Rubber planted with natural vegetation had a significantly higher stem girth (2.95 cm) and plant height (75.0 cm) compared with those in the intercrops. Among the intercropped, rubber + maize (0.50 x 0.75 m) had the most robust girth (2.74 cm) and height (90.7 cm^2). The result of the effect of intercropping on the grain yield of maize indicated a highest grain yield recorded in the Rubber + Cassava + Maize (0.50 x 0.75 m/1.0 x 1.0) treatment. While rubber + Cassava (1.0 x1.0 m) showed the highest Dry Tuber and Biomass yield of 9010 kg^{-1}ha and 11790 kg^{-1}ha. Rubber sapling biomass was significantly influenced by rubber based cropping systems. The Marginal rate of Returns in the rubber planted with natural and Pueraria recorded 0% compared with the ones planted with maize and cassava that recorded values ranging from 103.3 – 1826.4%. The study showed that intercropping rubber saplings with maize and cassava showed comparative advantage when compared with planting of rubber with Pueraria and natural vegetative fallow.
Keywords: Rubber saplings, intercropping, cassava, maize, Pueraria phaseoloides, crop spacing and Nigeria

Introduction
Intercropping of young rubber plantation with arable crops has been reported to be beneficial to the growth of rubber and capable of improving the economy of the rubber plantation enterprise in Nigeria. It has been reported to have the potentials of reducing farmer's need for subsidies and credit (Idoko *et al.,* 2012 and Esekhade *et al.,* 2003). Crops like maize and cassava has been found to be one of the most promising among the arable crops evaluated in Nigeria (Esekhade and Idoko, 2010; Esekhade, 2003). It an additional sources of organic materials to the soil and help create a micro climate that leads to soil moisture conservation and subsequent encouragement of a more robust girth of young rubber saplings on the field (Esekhade and Ugwa, 2000; Esekhade *et al.,* 1996; Esekhade, *et al.,* 2003). Before canopy closure, intercropping helps reduce the cost of rubber plantation establishment by generating income to farmers during the period of rubber establishment and thus less the need for subsidies and credit to rubber farmers. The intercropping of rubber with cassava and maize has been widely adopted by the small scale

farmers, but the practice is still not popular among the large scale estate in Nigeria despite the potential benefits of the practice. Some of the fears are the possibilities of component crops especially cassava reducing the growth of rubber due to competition for nutrients. However, results from research fields at Iyanomo and adoption studies carried out in some States proved otherwise. But that has not been enough in convincing major stakeholders in the rubber industries especially managers of estates.
Therefore, this paper seeks to demonstrate clearly, the impact of intercropping on the growth, development and yields of rubber, maize and cassava including possible financial benefits in rubber based cropping systems.

Materials and Methods

The experiment was conducted at the Rubber Research Institute of Nigeria, Iyanomo near Benin City located in the rainforest region of Southern Nigeria. Annual rainfalls during the two seasons of the experiment were 2352 and 2622 respectfully. The area has a bimodal rainfall distribution. The temperature is high, with a mean temperature ranges of 29.0 – 32.1 and 25.7 – 31.4 in the first and second season respectively. Selected physicochemical properties of the soils before cropping shows that the pH of the area was 6.00 and 5.70 in H_2O and KCl respectively, the organic carbon was 13.7g kg^{-1}, Total N was 2.4 g kg^{-1}, available P was 4.77 mg P kg^{-1}. The texture of the area was Loamy sand with a bulk density of 1.19 g cm^{3-1} and percentage moisture content of 12.2%. The experimental area was first opened for cropping about 50 years ago. The land utilization system since then has been 2 – 3 years of cropping followed by 5 – 6 years of bush fallow. The last fallow before the start of the experiment lasted for five years after it had been cropped to maize, yam, cocoyam, plantain and bananas for three years. The experimental plots were arranged in a randomized complete block design, with three replicates. Each plot measured 92.12 m^2 excluding 1.0 m^2 border to give a total area of 0.304 ha. The trials consisted of eleven treatments (rubber + natural vegetation fallow (Control), rubber + *Puereria phaseoloides*, rubber + maize (0.25 x 0.75 m), rubber + maize (0.50 x 0.75 m), rubber + maize (0.60 x 0.90 m), rubber + cassava (0.50 x 1.0 m), rubber + cassava (1.0 x 1.0 m), rubber + cassava (1.5 x 1.0 m), rubber + maize + cassava (0.25 x 0.75 m/0.75 x 1.0 m), rubber + maize + cassava (0.50 x 0.75 m/1.0 x 1.0 m) and rubber + maize + cassava (0.60 x 0.90 m/1.5 x 1.0 m). The natural rubber vegetation was established by allowing the growth of natural plants with rubber saplings, which was spaced at 6.7 x 3.4 m. The predominating plants were *Centrosema pubescens, Chromolaena odorata, Panicum maximum, Aspilia Africana and Talinum triangulare*. Maize (Zea mays L. cv DMR-SR-W), Cassava (Manihot esculentus Cranz cv. 30572) and Pueraria were established in the inter-rows of rubber sapling.

Agronomic parameters measured included morphological and physiological properties such as stem girth, height, leaf area, leaf area ratio and crop growth rates of rubber saplings were calculated according to Esekhade et al., (2003). Biomass of rubber saplings were determined by destructive samplings at 30, 360 and 720 days after planting (DAP). Yield of the intercrops were determined at harvest. Harvested rubber, maize and cassava were oven dried to 12 per cent moisture content at a temperature of 60°C. The soils of the experimental area were sampled before the start of the experiment and at the end of 720 days. The samples were from depth of 20 cm from the inter-rows and interlines of rubber. Particle size analysis was by the use of hydrometer method by Bouyoucos, (1965) method, organic carbon was determined using chromic acid wet oxidation method (Black, 1965), total nitrogen was by the micro Kjedahl method, available P was by the molybdenum blue colour method (Bray and Kurtz, 1945), exchangeable cations (Ca, Mg, Na and K) was determined by extracting with normal ammonium acetate and reading was with Atomic Absorption Spectrophotometer (AAS). Exchangeable acidity was determined by KCl extraction and titration with NaOH (Maclean, 1965). Based on soil test results, fertilizer were applied (uniform broadcast) at the rate of 19.0, 60.0, 36.0 and 5.0 kg ha^{-1} N, P_2O_5, K_2O and MgO; using Urea, Single super phosphate, muriate of potash and magnesium sulphate as sources respectively. The fertilizers were divided into two equal doses and applied at planting and 3 months after planting. All the data generated were analysed using the Analysis of variance (ANOVA) statistics and the means separated using the Least Significant Differences (LSD) at 0.05 level of statistical significance.

Results and Discussion

The results of the effect of rubber based cropping systems on some physic-physical properties of the soil (Table 1). Rubber + cassava system had the highest moisture content. This was as a result of effective ground cover and litter falls of cassava plants as reported by Idoko, et al, (2012). Organic carbon under the cropping systems changed from 16.5 g kg^{-1} soil before cropping to between 15.8 and 25.9 g kg^{-1} soil in the first cropping season. This is attributed to crop residue addition to the soil under the cropping systems Dalal and Mayer (1986) and Feller *et al*., 1987 showed that incorporation of crops residue provides substrate for microbial biomass resulting in increased soil aggregation, reduce erosion, BD and improved water conservation. Litter production and residue were highest in rubber + *Pueraria phaseoloides* and rubber + cassava systems respectively, but least in maize. This explains the increase in organic carbon in rubber + *Pueraria phaseoloides* and rubber + cassava systems compared with rubber + maize system. Nutrient content of crops in the intercropped plots had upward changes compared with pre-cropping values except total N. This could be as a result of the nature of crops and their combinations. This is why saplings in rubber + *Pueraria phaseoloides* systems had the highest percentage total N; while those in rubber + maize + cassava (0.25 x 0.75 m/0.50 x 1.0 m) system had the least N. This can be attributed to the N fixing capacity of *Pueraria phaseoloides.* The decrease in N content of rubber saplings on the other hand in the rubber + maize + cassava (0.25 x 0.75 m/0.50 x 1.0 m) system is attributed to the types of crops, plant population and their associated use of N and other inorganic fertilizers applied to the soil. Similar attributions were made by Zainol et al., (1993), working on the effect of intercropping systems on surface processes in an acid ultisols. Phosphorus accumulation was observed in all the soils under the rubber-based cropping system when compared with the pre-cultivated level, except rubber + *Pueraria phaseoloides* and rubber + maize (0.25 x 0.75m) systems, which both had values of 2.90 and 3.70 mg P Kg^{-1} in the soil. The observed decrease in both cropping systems is as a result of high P uptake. The accumulation of P in the soil could be attributed to P fertilizer application. The immobile nature of phosphates in soils has been implicated by some other workers (Mainstone, 1962; Pushparajah *et al.,* 1977 and Zainol *et al.,* 1993).

Build-up of exchangeable acidity and ECEC were also observed following intercropping. This is due to fertilizer application and residue addition to the soil. The observation agrees with that of Sanchez et al (1983) working on soil fertility dynamics after clearing tropical rainforest for cultivation. Rubber-based cropping systems influenced the morphological and physiological growth of rubber saplings; particularly girth and height measurements. Rubber saplings in rubber + natural vegetation, rubber + maize (0.50 x 0.75m) had the most robust and tallest height respectively (Table 2). Cropping systems involving *Pueraria phaseoloides* had the least rubber saplings; except that rubber saplings in rubber + cassava (1.0 x 1.0) and rubber + maize (0.60 x 0.90) had the highest crop growth rates (CGR) (0.10 g^{2}m$^{2-1}$ day^{-1}), net assimilation rates (NAR) (8.4 x 10^{-4}g^{2}m$^{2-1}$ day^{-1}) respectively. Rubber saplings in *Pueraria* plots also had the lowest CGR and NAR. *Pueraria phaseoloides* tends to compete more for nutrients particularly P and other resources than rubber saplings. This explains its adverse effects on the growth of rubber saplings compared with food crops. Similar observation was made by Watson (1989) in his study on the role of trees and cover crops in nutrient cycles. He observed apart from accumulation of large amount of nutrients, *Pueraria phaseoloides* strangulates young rubber of not controlled. Rubber-based cropping system did not have significant effect on morphological measurements of maize and cassava (Tables 2). The spacing/plant population seem not to have adversely affected morphological measurements. However, maize plants in rubber + maize + cassava (0.50 x 0.75 m/1.0 x 1.0m) had the tallest height and widest leaf area. While cassava plants in rubber + maize + cassava (0.60 x 0.90m/1.5 x 1.0m) and rubber + maize + cassava (0.50 x 0.75/1.0 x 1.0m) had the most robust girth and tallest height respectively.

The yield of rubber, maize and cassava were significantly ($P \leq 0.05$) influenced by intercropping (Table 2). The highest rubber biomass was 65.1 Kg ha^{-1}, while the least was 42.4 Kg ha^{-1} in rubber + cassava (1.0 x 1.0 m) and rubber + *Pueraria phaseoloides* systems respectively. This result suggest that crop population may affect the biomass of rubber saplings in a rubber based cropping systems due to increase competition for resources, also the types of crops in the mixture could also affect the rubber sapling biomass, as demonstrated by the biomass of rubber in the in rubber + *Pueraria phaseoloides* and rubber + natural vegetation systems compared with rubber + maize and rubber + cassava systems. These could be due to complementation of plants species mixture in maize, cassava and rubber intercropping systems. This is in agreement with the views of Idoko, *et al*., (2012), Ong and Black (1992) and Willey *et al.,* (1986). Maize grain yields in cropping systems did not follow definite pattern. A higher maize population per plot did not necessarily results in higher grain yield, neither did a lower maize production resulted in lower, maize grain yields. Rubber + maize (0.60 x 0.90m/18519 plants ha^{-1}) had higher mean maize grain yield (2390 Kg ha^{-1}) compared with maize yield in rubber + maize (0.25 x 0.75m/53333 plant ha^{-1}) which was 2035 Kg ha^{-1}. The same was true for rubber + maize + cassava systems where the (0.50 x 0.75m/(26667 plants ha^{-1})/1.0 x1.0/(10000 plants ha^{-1}) spacing population. However the rubber + maize (0.50 x0.75m) and rubber + maize + cassava (0.50 x 0.75m/1.0 x1.0m) systems seem to have a more positive effect on the growth of rubber saplings and yields of maize. Cassava yields were however, more consistent in terms of the effect of the cropping systems on yield. Cassava spaced at 1.0 x 1.0m/10000 plants ha^{-1} consistently maintained the highest cassava tuber yields. Rubber + cassava (1.0 x 1.0m) and Rubber + maize + cassava (0.50 x 0.75m/1.0 x 1.0m) systems had 9010 and 1790 Kg ha^{-1} cassava tuber yields respectively. The introduction of maize into cropping systems led to a decrease in tuber yields of cassava. This could be explained by the reduced space available to cassava under the rubber + maize + cassava system compared with the rubber + cassava system.

Conclusion

The study was carried out to determine the optimum spacing/plant population of maize and cassava intercropped with rubber saplings and the effect of the intercropping systems on rubber saplings growth and yield. The major findings of the trial are summarized as follows; The nature and number of intercrops with rubber saplings influenced the growth and development of rubber saplings. Rubber saplings intercropped with *Pueraria phaseoloides* had the highest growth performances compared with those planted with maize and cassava. The spacing recommendation for maize and cassava intercropping in a rubber based cropping system are 0.50 x 0.75 cm and 1.0 x 1.0 m respectively.

Table 1: Effect of Rubber based cropping systems on the morphological growth of rubber, maize and cassava

Cropping systems	Rubber growth (cm)			Maize growth (cm)			Cassava Growth (cm)		
	Girth (cm)	Height (cm)	Crop Growth Rate ($g/m^2/day$)	Height	Leaf Area	No. of leaf	Girth	Height	Leaf area
Rubber + Natural vegetation	2.95	75.1	0.06	-	-	-	-	-	-
Rubber + Pueraria Phaseoloides	2.15	52.7	0.03	-	-	-	-	-	-
Rubber + Maize (0.25 x 0.75 cm)	1.78	35.8	0.04	62.2	428.2	12.6	-	-	-
Rubber + Maize (0.50 x 0.75 cm)	2.74	90.7	0.06	63.3	443.7	13.2	-	-	-
Rubber + Maize (0.60 x 0.90 cm)	2.09	44.4	0.07	55.7	436.0	12.1	-	-	-
Rubber + Cassava (0.5 x 1.0 m)	2.43	54.3	0.04	-	-	-	7.83	243.3	90.4
Rubber + Cassava (1.0 x 1.0 m)	2.05	43.3	0.10	-	-	-	7.42	243.1	89.9
Rubber + Cassava (1.5 x 1.0 m)	2.31	48.3	0.06	-	-	-	8.74	235.2	100.4
Rubber + maize + Cassava (0.25 x 0.75 cm/0.50 x1.0 m)	2.69	60.7	0.03	57.8	455.7	11.8	7.34	237.4	99.9
Rubber + maize + Cassava (0.50 x 0.75 cm/1.0 x1.0 m)	2.67	57.4	0.01	70.0	468.7	14.3	7.93	252.0	106.2
Rubber + maize + Cassava (0.60 x 0.90 cm/1.5 x1.0 m)	2.05	50.6	0.04	63.0	436.6	13.1	8.83	243.4	103.5
LSD ($P \leq 0.05$)	0.30	20.6	0.01	ns	Ns	Ns	ns	ns	

Table 2: Effect of Rubber based cropping systems on the yield of rubber, maize and cassava

Cropping systems	Rubber biomass Yields (Kg ha^{-1})	Grain yield of maize		Cassava tuber Dry matter yield	Marginal rate of return (%)
		First season	Second season		
Rubber + Natural vegetation	50.6	-	-	-	0
Rubber + Pueraria Phaseoloides	42.4	-	-	-	0
Rubber + Maize (0.25 x 0.75 cm)	45.6	2350	1720	-	736.0
Rubber + Maize (0.50 x 0.75 cm)	50.1	1740	1700	-	9473.6
Rubber + Maize (0.60 x 0.90 cm)	56.9	3000	1780	-	8434.5
Rubber + Cassava (0.5 x 1.0 m)	54.3	-	-	5500 ± 350	300.0
Rubber + Cassava (1.0 x 1.0 m)	65.1	-	-	9010 ± 171	4807.2
Rubber + Cassava (1.5 x 1.0 m)	53.3	-	-	1370 ± 368	54523.3
Rubber + maize + Cassava (0.25 x 0.75 cm/0.50 x1.0 m)	51.3	2330	1200	1470 ± 488	1861.5
Rubber + maize + Cassava (0.50 x 0.75 cm/1.0 x1.0 m)	45.6	3050	1520	1790 ± 378	9840.0
Rubber + maize + Cassava (0.60 x 0.90 cm/1.5 x1.0 m)	43.6	1900	1800	1530 ± 304	20580.0
LSD ($P \leq 0.05$)	10.2	950	310	597	

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Production of Improved Timber Trees Resistance to Pests and Diseases

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Abstract
The biodiversity of the forest determines the health and vitality and is the basis for a wide range of ecosystem services necessary for people's livelihoods and well-being. These services are seriously impaired because of pest and diseases. In timber production, diseases and pests have caused timber degradation resulting in reduction of harvestable volumes and quality of timber. A key element of successfully managing forests for sustainable resilience to invading pests and pathogens is to harness the genetically controlled resistance mechanisms that are naturally present in trees. Breeding disease resistance timber tree species can provide a long-term solution which has no detrimental side effects to the environment unlike the use of chemicals. Though, breeding for resistance trees is challenging in Forestry due to the long maturity period of forest trees but some successes have been recorded.

Introduction
Forests provide approximately 1.6 billion people with food, medicines, fuel and other necessities. These provisions of the forest could be attributed to its biological diversity. Forests are more biologically diverse than any other land-based ecosystem. Biodiversity determines the health and vitality of forests and is the basis for a wide range of ecosystem services necessary for people's livelihoods and well-being (SCDB, 2010) Unfortunately, invasive pathogen and insect species can have a significant negative effect on the health and biodiversity of forest ecosystems, urban forests and forest plantations, which in turn can have large economic impacts, if they are kept unchecked (Lovett et al. 2016; Roy *et al.* 2014; Campbell and Schlarbaum 2014; Pimentel *et al.* 2000). In Africa and other parts of the world, there are some pest and disease problems which are often overlooked but their cumulative effect could cause great economic losses, whether in commercially exploited natural stands or in plantation. Consequently, the integrity of our natural, urban and plantation forest ecosystems, and the services they provide are seriously impaired because of pest and diseases (Sniezko and Koch, 2017). Hardwood tree species have suffered the greatest destruction. There are several examples where one or more species of either indigenous or exotic pests or diseases have caused devastating losses to forests, requiring changes in management regimes or to switch to alternative tree species (FAO, 2001). For example, in timber production, diseases and pests such as heart rots and bark beetles respectively, have caused timber degradation resulting in reduction of harvestable volumes and quality of timber (Nsolomo and Venn, 2000; Ryvarden, 1980). In addition, trees planted on farm woodlots and urban spaces have also at times succumbed to diseases and pests (Nsolomo and Venn, 2000). Utilizing naturally occurring genetic resistance can provide solution that fosters continuous coevolution of the affected tree species and the damaging agent that is vital for long-term success. Genetic resistance has the advantage of being a natural alternative to the use of chemicals or other costly management methods that may have to be continuously repeated or may have detrimental side effects to the environment (Sniezko and Koch, 2017). This review highlights pest and disease of timber trees. The challenges and successes in developing resistant forest trees.

Common Pests and diseases of forest trees
Pests and diseases can damage trees in all stages of development. For instance, some fungi and insects are pests of tree seedlings in nurseries while others attack older trees in a wide variety of ways (FAO, 2001). Some indigenous tree species in Nigeria, with endemic pest problems

include Iroko (*Milicia excelsa* and *M. regia*), African mahogany (*Khaya and Entandrophragma spp*), Afrormosia (*Pericopsis elata*), Obeche (*Triplochiton scleroxylon*), Opepe (*Nauclea diderrichii),* and *Terminalia ivorensis.* Plantation establishment of these high value indigenous timber species is impaired as a result of these endemic pest problems (Gichora *et al.,* 2017; Paul and Weber, 2013). *Milicia excelsa* suffers severe attacks from the Iroko gall maker *Phytolyma lata* (Wagner et. al., 2008). Other species of Phytolyma namely P. fusca and P. tuberculata attack M. regia. All life stages of the tree are attacked but seedlings and actively growing saplings in young plantations are most affected, often resulting in total failure of plantation establishment.
Another serious pest of regional and global significance is the mahogany shoot borer, *Hypsypyla robusta*. It attacks species of the Meliaceae family in Africa, especially African mahogany (Khaya and Entandrophragma). Shoot borer attack on mahogany often results in damage and deformation and sometimes death of plants at the nursery stage and in young plantations. Other important endemic pests include *Lamprosema lateritialis* on *Pericopsis elata* (Afrormosia), *Orygmophora mediofoveata* on *Nauclea diderrichii* (Opepe) and *Anafe venata* on Triplochiton scleroxylon (Obeche).

In addition to the problems encountered on indigenous species, introduced or exotic species such as *Gmelina arborea, Cedrela odorata, Tectona grandis* and various *Eucalyptus* species which are widely planted in Nigeria often succumb to insect pest attacks (Gichora *et al.,* 2017). In the humid forest zone, *Gmelina arborea* suffers from severe attack by *Achaea* and *Apophylia* species, these have resulted in significant damage in Nigeria in the past (Louppe, 2008). *Tectona grandis* (Teak) and *Cedrela odorata* (Cedrela) are perhaps the most commonly planted species in the humid zone of West Africa and occur in Ghana, Togo, Nigeria and Cote d'Ivoire. The two species do not have serious problems with insect pests, except for sporadic attacks by some generalist insects.

Mechanism of resistance to pest and diseases

A key element of successfully managing forests for sustainable resilience to invading pests and pathogens is to harness the genetically controlled resistance mechanisms that are naturally present in trees (Cavers and Cottrell, 2015; Ledig, 1988), as part of an integrated management strategy. Tree resistance to pests and pathogens is either at the cellular, tissue or whole tree levels (Telford *et al.,* 2015; Namkoong, 1991). Tree resistance is the ability of the tree to exclude or overcome, completely or in some degree, the effect of a pathogen or other damaging factor (Agrios, 2005). It could also be referred to as the ability of an individual host tree to use genetically encoded mechanisms to defend against or withstand attack by an invading organism, with an associated and measurable increase in fitness compared with hosts who do not employ these mechanisms (Telford *et al.,* 2015). Resistance to pathogens is often categorized as either complete (qualitative) or incomplete (quantitative) but the dichotomy between these is not always clear (Kovalchuk et al. 2013; Poland et al. 2009). Complete resistance is often the effect of a single major gene. screening for complete resistance to some fungal pathogens is relatively easy such as *Cronartium ribicola* that causes white pine blister rust, because it can often be done on very young seedlings and the ratio of canker-free (or surviving) individuals is often moderate to high versus the susceptible controls (Sniezko *et al.,* 2012; Kinloch *et al.* 2003). Unfortunately, single gene resistance can often be overcome by pathogens capable of rapidly evolving (Dowkiw *et al.* 2012; Kinloch et al. 2004; McDonald and Linde 2002). Quantitative resistance is the result of the actions of many different genes, and is therefore less likely to be overcome by evolution of the pathogen. Unlike animals, plants lack immune system but have developed an innate immunity made up of several structural, chemical, and protein-based defenses designed to detect and prevent invading organisms (microbes, pests and herbivores). These defense mechanisms can be grouped into two: Pre-existing and post-existing (Doughari, 2015; Naidoo *et al.,* 2014). The pre-existing, also called preformed, passive or pre-invasive. These defense mechanisms are those that are present before contact with the pathogen. They are natural barriers presented by healthy plants. These barriers prevent pathogen entry (Laluk and Mengiste, 2010). In order words, they are innate basal first line immune defence devices indigenously constitutive in the plant even before colonization by the pathogen hence the name constitutive defense (Doughari, 2015). These barriers may be structural/physical (the cuticle, cell wall, stomatal aperture or lenticel) or biochemical (including inhibitory compounds or the absence of stimulatory compounds needed for pathogen development (Freeman and Beattie 2008; Agrios, 2005). Saprophytes lack the ability to penetrate these natural barriers (Quest and Brown, 1997).

In summary, passive defense allows the tree to prevent or inhibit invasion, then kill or isolate the pest or pathogen and repair any damage that has been caused (Franceschi *et al*., 2005). Post-existing is active or induced defense. It is confrontation through interactive resistance mechanisms which slow or prevent infection or attack. Just like pre-existing, it could be structural or biochemical (Agrios, 2005). Induced structural defense may be histological (Lignification, suberization, abscission layers, tyloses, gum deposition) or cellular (cytoplasmic reaction, papillae). In Eucalytus species, Cell wall lignification, phenol deposition and callused papillar formation were observed more frequently in E. calophylla and E. maculate resistant to p cinnamomic. Induced defences may operate locally at the site of infection, or systemically throughout the entire plant via signalling and transportation of defence compounds to other tissues (Eyles *et al*., 2010). Cahill and McComb (1992) reported an increase in the phenilalanine ammonia liase (PAL) activity, a key-enzyme in phenol propanoid, lignin and phenol product biosynthesis. This increase was detected 48 hours after infection by P. cinnamomi in *Eucalytus calophylla* roots which were resistant in the field. However, these changes did not occur in roots of susceptible *E. marginata* species. *E.calophylla* resistance to *P. cinnamomi* was associated with phenol production. Similarly, *Laccaria bicolor* prevented *Fusarium oxysporum* from degrading the host cell wall due to production of flavanolic infusion in the cell wall. *L. bicolor* stimulated the accumulation of tanine condensates between cortex cells, which indicated that these phenolics were the root protection base (Strobel and Sinclair, 1991; Sylvia and Sinclair 1983). However, most mechanisms do not provide complete resistance. Probably plants use a combination of these mechanisms in a coordinated and integrated response to reduce the success of the pest and pathogens (Poland *et al*., 2011; Bonello *et al*., 2006).

Developing genetic resistant trees to pest and diseases

Trees are perennial, long-lived organisms, durable resistance is needed to ensure the trees survive long enough to meet ecologic goals in natural forests and economic or amenity goals in plantations or urban forests. Breeding disease resistance forest tree species can provide a long-term solution, but it can also be a long-term endeavor. The characteristics of forest trees such as long maturity period, makes breeding differs from agricultural crops especially if multiple generations are needed (Flachowsky *et al*.,2009; Fladung, 2008). In agricultural crops, pure cross-breeding is utilized, i.e. after an initial cross between a wild plant (carrying e.g. a resistance gene) with an elite line (deficient in the resistance gene), repeated back-crosses and field testing ensures the presence of the resistance gene together with the accumulation of the genomic background of the elite line. Unfortunately, the long gestation /maturity period in forest trees makes pure cross breeding not practicable. However, the term selective breeding is used in forest tree breeding. This is selection of natural occurring forest trees with the desired traits such trees are called plus trees (Haggman et al., 2016). These trees are used for seed collection or establishment of seed orchard. This makes the resistant tree not a single cultivar, but a genetically diverse progeny that resulted from inter-mating of a population of resistant parents. Seed orchards typically have an advantage over seed collected from parent trees in natural forests because all pollination is from resistant parents, increasing the level and frequency of resistance in the resulting seed (Haggman *et al.*, 2016; Sniezko *et al* 2012). Despite these challenges in breeding for resistant forest trees, there are some successes in relatively short periods of time (Sniezko *et al*., 2012; Koch 2010). For instance, *Swietenia macrophylla* and *Cedrela odorata*, resistant to *Hypsipyl grandella* were produced by grafting using *Khaya senegalensis* and *Toona ciliate* (Perez *et al.,* 2010). In addition, the tissue culture technique which has become an important tool in plant breeding to develop disease resistant plants through either micropropagation or cell culture in selective medium, in the presence of fungi phyptotoxins (Sobrosa and Martins-Corder 2001) has recorded some successes in forest tree breeding for resistance variety. In a study on breeding for pest resistance, Klopfenstein *et al.* (1993) analyzed two Populus hybrids, which were transformed with defense genes from quimeric plants developed based on the pin2 gene (potato proteinase inhibitor II). A binary vector system of Agrobacterium was used in the transformation of these hybrids. The expression of genes was conformed in Populus transformed with Nos PIN2 or 35S-PIN2. Populus transgenics expressing PIN2 showed resistance to insects (Plagioder versicolora and Chrysomela scripta) and fungi pathogens (Septoria musiva and Melampsora medusae). Cahill *et al.* (1992) observed, in roots inoculated with P. cinnamomi, that 8% of the primary roots of micro propagated

Eucalyptus maginata resistant clone could restrict and limit colonization of this pathogen. However, no root of susceptible plants of this species restricted the fungus growth. The authors also observed that while there were few lesions in the *E. marginata* clones, their length was like that found on the roots of susceptible plants. In Pines, the study of Jang and Tainter (1990), shows that expression of differential resistance in callous tissues of three Pinus species (*P. taeda, P. echinata, P. virginiana*) and a hybrid of *P.taeda x P echinata* in response to cinnamomi a fungus infection showed that *P. taeda* and the hybrid were more resistant to infection and invasion by the fungus than *P. echinata* or *P. virginiana*. Similarly, *Pinus wallichiana* which has proven blister rust resistance (caused by *Cronartium ribicola*) became desirable resistance gene donor to *Pinus strobus* which is susceptible to the disease. Currently, seedlings from the second-generation backcrosses (with 87.5% parentage from *P. strobus*) have confirmed satisfactory rust resistance (Lu and Derbowka 2009),

Conclusion

The integrity of our natural, urban and plantation forest ecosystems and the services they provide are vital for human existence. This paper has been able to establish that, the identification and selection of trees with natural genetic resistance will help to improve the long-term resistance and resilience of tree species to infection or herbivory. Therefore, policies and practices that influence forest management must aim to prevent damages cause by pests and diseases, rather than to treat/manage them once they are fully established.

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Sustainable Management of Forest Resources for Food Security in Nigeria

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Abstract
This paper provides information on the relevance of forests and tree-based systems for food security and nutrition, and indicates where there is a need to further quantify the roles of these systems, allowing proper integration of their contribution into national and international developmental policies. It also highlights the important role of agricultural revamping in overturning the food insecurity problems that befell Nigeria and the coping strategies.
Keywords: Food Security, forest resources, nutrition and hunger

Introduction
The role played by forests and trees in the lives of many people appears obvious through the many uses made of tree products, including foods, medicines, fodder, fibres and fuels, and for construction, fencing and furniture (FAO, 2010). Indeed, forests and other tree-based production systems such as agroforestry have been estimated to contribute to the livelihoods of more than 1.6 billion people worldwide (World Bank, 2008). Forests have sustained life on earth through the ages. They supply food, medicine, energy, shelter, fodder, wood and non-wood forest products and are a source of economic development for individuals and communities. They have cultural and spiritual values, protect biodiversity and conserve soil and water. Forests are indeed a source of life. Forestry can contribute immensely to food security in Nigeria if properly integrated with agriculture, fish and livestock production. Forests and tree-based agricultural systems contribute directly and indirectly to the livelihoods of an estimated one billion people globally. Wild foods are important for food security and nutrition while trees and forests are vital for their role in the provision of ecosystem services to agriculture. Despite this, the role of forests in supporting human food security and nutrition remain largely under-researched and understood. With food security and nutrition high on the agenda in many political and scientific spheres, it is crucial to understand the contribution of forests and trees to a food secure and nutrition-sensitive future. This improved understanding will be essential for building on synergies and minimizing trade-offs between biodiversity conservation and sustainable management of forest resources in order to feed an estimated global population of nine billion people by 2050 (Sunderland *et al.*, 2013).

Food Security and Nutrition
Food security exists when communities "have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life" (Pinstrup-Andersen, 2009). Despite advances in agricultural production globally, approximately one billion people are still chronically hungry, two billion people regularly experience periods of food insecurity and just over a third of humans are affected by micronutrient deficiencies (FAO *et al*., 2012; UN-SCN, 2010; Webb Girard *et al*., 2012). While rates of hunger (insufficient access to energy) have been falling in many parts of the Nigeria, there has been little change in the rates of micronutrient deficiencies (FAO *et al*., 2013). In particular, deficiencies of iron, vitamin A, iodine and zinc, are associated with poor growth and cognitive development in children, and increased mortality and morbidity in both adults and children (Black *et al*., 2013).

Food insecurity in Nigeria

Unfortunately, the problem of food insecurity is still relevant in Nigeria. 1/6 of the Nigerian population suffers from chronic hunger; 3.8 million of them are children, who die every year as a result. The inability of Nigeria to provide the population with the required sustenance is mainly due to stagnation of agriculture. Another reason is low income of many families.

Causes of Food Insecurity

Food insecurity is a multifaceted problem. It is quite an uphill task discussing the driving factors for food insecurity in Nigeria. The following among others have however, been identified as the prime agents of food insecurity in Nigeria.

Insufficient Production

While Nigeria only has a fixed area of arable land, its growing population will soon stretch land availability to it limits that it will not be able to sustain the population. The major problem here is that the agricultural sector has remained under developed and depended too much on primary agriculture system with degraded low fertile soils, less external farm inputs utilization and significant loss of food crops both before and after harvest, and lack of facilities for storage and preservation of food all of which have cumulatively contributed to price fluctuation of agricultural products (Ilaboya, *et al*., 2012).

Inefficient Policies and Corruption

Food insecurity has persisted in Nigeria and many developing countries because of inefficient policies especially with respect to agriculture, trade, economics and other adjourning sectors. If governments fail with these policies, hunger will naturally persist or even worsen. Indeed, many countries have failed in their efforts to develop due to failure to properly administer policies and initiatives which has connection to food (Behnassi, *et al*., 2011).

Climate Change and Natural Disasters

Global changing climate is another important driver of food insecurity that cannot be underestimated. Amongst other impacts, climate change is responsible for biodiversity loss in the ecosystem as well as other physical access (Adeagbo, 2012). Climate change has become one of the key divisor that is redefining the global food equation and thus having so much impact on the food security of particularly developing nations.

Low Technology for Processing and Storage

The use of modern technologies in the production and distribution of agricultural products is very low in Nigeria so the sector depended more on manual labour for farm activities. This is because of lack of innovation in local technology, particularly as it relate to mechanization of agriculture to improve productivity. Additionally, local farmers can hardly afford imported technologies and lack maintenance capacity (Nwajiuba, 2013). Inadequate or lack of facilities to preserve food items such as cereals, yam, beans, etc. can result in wastage thereby further deepening the insecurity level of food. Also, lack of food processing apparatus sometime leave farmers with no choice than to consume significant fraction of their harvest within short period.

Nigerian Food Security Policy Review

The Nigerian government has come up with various strategies to improve the situation. Efforts are now been made to restore agriculture back to its original status before the oil boom and stamping out food insecurity (Ojo and Adebayo, 2012). Several policies and initiatives are now being developed with the aim of providing efficient framework to address food insecurity and malnutrition in Nigeria (Akinyele, 2009).

Strategies for Achieving Food Security in Nigeria

Going by its definition, food security however will not be achieved by simply increasing the production of food. Even when food is sufficiently available, a poor hungry man will remain food insecure as long as he cannot afford to buy it (Ogbonna *et al*., 2013). Hence, all four components viz.; availability, accessibility, utilization and stability must be present. Efforts to combat food insecurity will therefore, not only make food available but also ensure that that people can consistently afford to make it ready for consumption. The panacea lies in improving forest resource production; enhancing science and technology; building farmers capacity; facilitating access to the market; and good governance amongst others (Ilaboya, *et al*., 2012).

Sustainable use of the forest resource base
Sustainable use of forest resources is critical for sustainable livelihoods. More sustainable use of natural resources has a direct impact on the improvement of natural capital. All people affect the environment, but the poor tend to be the most vulnerable to the effects of environmental degradation (FAO, 2010). The development and sustainable management of forest resources is simply the process of managing resources derivable from the forest so as to ensure persistent and sustained availability of forest goods and services for the teeming global population. Unlike the past in which forest was treated with a wave of the hands as a result of finding them everywhere, forest resources in recent times are increasingly and significantly constituting prominent element in the national economies of many countries (Ojo and Adebayo, 2012)

Conclusion
We believe that forests, biodiversity conservation and agro-ecology should feature prominently in political and scientific discourse on agricultural production and the concomitant challenge of sustainable forest resources. Greater attention to the direct and indirect benefits of forest in food security, livelihoods and nutrition should enhance local and global efforts to end hunger and improve the nutrition of communities living in forested areas as well as those living in areas removed from forests. To surmount this challenges, the government must go back to the drawing board to provide enabling environment through promoting decent employment in the agricultural sector and non-farm sectors as well as providing credit facilities to serve as platform for the most vulnerable to cope with the economic realities particularly in the rural areas. While social networking and cooperation among small holder farmers will give them a voice, the government needs to provide basic infrastructures such as access road and electricity and make education more accessible to build farmers capacity. Oil spillage and other industrial effluents constitute a major source of pollution of soil and water and other components of the environment, thereby reducing agricultural productivity. There is the need for government to develop a robust monitoring mechanism to control indiscriminate discharge of effluent. Lastly, modern science and technologies must be adopted to improve agricultural productivity.

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Tree Species Density, Diversity and Distribution in Kano State Zoological Garden, Kano State, Nigeria

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Abstract
The study was carried out to determine the density, diversity and distribution of tree species in Kano State Zoological Garden, Kano State Nigeria. Total of Twelve plots of 50×50m were laid in the study area. All trees with diameter at breast height (DBH) 10cm and above were identified, diameter at breast height (DBH) measured and their frequencies were taken in all the sample plots. There were total of 1,030 trees which belong to 35 species and distributed among 15 families. 44.56% of the tree species encountered belongs to the family Fabaceae, 21.7% Meliaceae, 0.35% Ebanaceae and Aracaceae respectively. The Shannon Wiener diversity index (1.113) Simpson`snindex (0.001) and species richness (0.16) were estimated. The distribution of tree density per hectare was 103 trees per hectare. Khaya senegalensis has the highest mean height values 30.34m with DBH of 1.67, Terminalia catappa of 4.50m with DBH of 0.11m while Ficus platyphylla had lowest DBH value of 0.10m with mean height of 4.00m. This study provides the baseline information in relation to biodiversity of trees species in Kano State Zoological Garden, which has greater impact on survival of zoo animals and satisfaction of visitors. The result of floristic status obtained from the research indicated that Kano Zoo is moderately dense with diverse vegetation.
Keywords: Kano zoological Garden, Density, Diversity and Distribution

Introduction
Forest monitoring has become a key issue in national and international environmental and developmental policy process. This is especially true in the tropical forests where rates of the degradation and fragmentation are high. The information generated by the forest inventory and monitoring system not only feeds into national environmental policies but also plays an increasingly relevant role in international conventions (FAO, 2013). It is increasingly evident that forest provides indispensable functions in a complex ecological system which sustains not only humans but all life on the planet earth. Everyone is benefiting from the products or services of the forest. In addition forests also have added value of conservation for scenic purposes, stabilization of climate, maintenance of water supply and prevention of soil erosion (Nemetz, 1992). Conservationist widely believe that the more species an ecosystem contains, the more robust and stable it will be (William, 1994). Talman (1990) pointed out that the more species the ecosystem has, the more likely it is that such forest will be resistant to drought, disease or any other stress that can threaten it. These resistant species spread and take the place of those harmed or killed by the stress. Density of species in an area is often described by the total number of particular species per unit area, which indicates the relative abundance of particular species in a counting of different species or forest. Density technically is more effective when measuring either species recruitments or mortality (William, 1994). A density has been particularly useful in monitoring threatened and endangered species or other species of plants, because it samples the number of individual per unit area (William, 1994). Density of tree species in different size or age class is often used to quantifying how range lands are responding to different management actions and disturbances. Many threatened or endangered species are at risk because of disruptions to their habitats (NWF, 2013). While some species can rely on diverse sources of food or places to breed, a surprising number of species are very specific in their requirements. For example, certain butterflies can only lay their eggs on particular host plants

that provide food for their caterpillars. Some bird species have very particular nesting requirements that are only met by certain kinds of trees (NWF, 2013). Wildlife has four basic requirement: food, cover, water and space. Different wildlife species require different stages of forest growth to meet these needs. The arrangement and ratio of these stages dictats the kinds of wildlife that can live on your land, source www.geogiawildlife.com. Assessment and systematic observations are essential components of long term planning, for evaluating effects, quantitatively and qualitatively, and for rectifying inadequacies. Over the years information on the floral composition and density is not documented in the Kano state zoological garden. Hence vegetation survey becomes imperative since it is the vegetation that supports wildlife. The objectives of this research was to determine the floristic status (density, diversity and distribution) of Kano State Zoological Garden, Kano State, Nigeria.

Methodology

The Study Area

Kano Zoo is one of the largest state governments owned zoo in Nigeria (Bichi, *et al.,* 2016). It was established in 1971 and officially opened in 1972 by the military governor of Kano State, Alhaji Audu Bako. Kano state Zoological Garden is located within Kano metropolis with the latitude 11º 57` 48.1 and 11º 58`00.0 North and the longitude 11º 58` 09.3 and 11º 58`20.0 East. It is within the Sudan Savanna zone of West Africa. The temperature of Kano usually ranges between a maximum of 33°C and a minimum of 18.85°C although sometimes during winter it falls down to as low as 10°C (Bichi, *et al.,* 2016).The zoo covers an area of about 46 hectares with about 75 different species, comprising about 350 animals. It was registered by Pan African Association of Zoos and Aquaria (PAAZA) and International Zoo Educators (IZE) in 2007 and 2010 respectively.

Sampling techniques and data collection

Kano zoo has an estimate of 46 hectares. The zoo was divided in to plots of 50m×50m, thereby having a total number of 92plots/area. Twelve (12) plots were randomly selected for this study which was 13% of the total plots. Within each selected plot, complete enumeration and tagging method was used to collect the data. Information on total number of species per plots and relative abundance of all living tree was recorded. The measurement of tree diameter at breast height (dbh), and their respective total height was done with Spegiel Relescope, and Girth diameter tape.

Data Analysis

The data collected was arranged in Microsoft excel spreadsheet and the following growth and diversity indices were computed from the data obtained. The parameters considered include; Basal area, frequency, relative frequency, relative density, relative dominance and important value index, Shannon and Simpson diversity index.

The basal area of all trees in the sample plots was calculated using the formula:

$$BA=\frac{\pi D^2}{4} \quad (1)$$

Where, BA= Basal area (m^2), D = diameter at breast height (m) π = pie (3.143). The total basal area (m^2) for each plots was obtained by adding all the trees in the sample area and the mean basal area was calculated for individual species. Below is the quantitative formula used in calculating density and diversity indices from the study area:

$$\text{Frequency} = \frac{\text{Number of plots in which species occurs}}{\text{Total number of the plots}} \times 100 \quad (2)$$

$$\text{Relative frequency} = \frac{\text{frequency of a species}}{\text{total frequency of all species}} \times 100 \quad (3)$$

$$\text{Relative density} \frac{\text{Number of individuals of the species}}{\text{Total number of individual of all the species}} \times 100 \quad (4)$$

$$\text{Relative dominance} \frac{\text{Total basal of a species}}{\text{total basal area of all the species}} \times 100 \quad (5)$$

Importance Value Index (IVI) = Relative frequency+ Relative density + Relative dominance (6)

Below is also the formula for qualitative analysis:
Species diversity and dominance will be calculated from a Shannon diversity index given as:
Shannon Diversity index:

$$H = -\sum_{i=1}^{S} p_i \; In \; p_i \; \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . (7)$$

H= Shannon – Weaver Index (summation of Pi × In Pi ×(-1)), Pi = the proportion of species in the population (Pi = $\frac{ni}{N}$), Where ni = number of individuals of a species,N= the total number of individuals, In Pi = the logarithmic proportion of the species.

$$\text{Species evenness} \quad E = \frac{H}{logs} \qquad (8)$$

E = evenness,
S= number of species present.
Log= logarithm

$$\text{Species richness} = \frac{\text{total number of tree species} - 1}{\text{Log of total number of all individuals of th tree species}} \qquad (9)$$

$$\text{Simpson`s Index (D)} = \frac{\sum ni\,(ni-1)}{N(N-1)} \qquad (10)$$

Where:
D = Simpson`s index
n_i = number of individual species i
N = total number of all tree species in the entire community

Results and Discussion

Table 1 shows the species compositions, families, mean height, mean diameter at breast height (dbh) as well as number of individual. *Khaya senegalensis* has the highest mean height value of 30.34m; followed by *Eucalyptus microcarpa* 30.00m; *Gmelina arborea* 24.14m; *Tectona grandis* 23.75m;; and *Delonix regia* 17.13m; *Dalbergia sisso* 15.96m, while *Terminalia catappa*, *Ficus benjamina* and *Ficus platyphylla* has the lowest mean value of 4.50m, 4.00m and 4.00m respectively. *Khaya senegalensis* had highest mean diameter at breast height (dbh) of 1.67m; *Adansonia digitata* 1.19m; *Tectona grandis* has 1.18m *Eucalyptus microcarpha* has 0.78m and *Delonix regia* 0.71m, while *Diospyros mespiliformis;; Annona squamusa; Terminalia catappa, Ficus benjamina,* and *Ficus platyphylla* had the lowest mean diameter of 0.11m, , 0.11m, 0.11m, 0.11m and 0.10m respectively. Table 2 presents the relative density of the families encountered in the study area *Fabaceae* had the highest family relative density of 44.56%; followed by *Meliaceae* with 21.75%; *Myrtaceae* has 7.02%; *Moraceae* has 4.21, while *Zygophyllaceae, Annonaceae, Casuarinaceae, Ebenaceae* and *Arecaceae* has the lowest relative density of 1.40%, 1.05%, 0.70%, 0.35% and 0.35% respectively. Table 3 shows the frequency; relative frequency; density per hectare; relative density, basal area distribution; relative dominance; important value index; species richness and Shannon weinner diversity of trees in Kano State Zoological Garden. The result indicated that *Azadirachta indica* and *Albizia lebbeck* has 100% frequency while *Diospyros mespiliformis, Annona squamosa, Casuariana equisetifolia, Ficus platyphylla, Hyphaene thebaica* has the same frequency 8.33%. *Azadirachta indica* and *Albizia lebbeck* recorded as a specie with highest relative frequency 10% while *Diospyros mespiliformis, Annona squamosa, Casuariana equisetifolia, Ficus platyphylla, Hyphaene thebaica* also has the same relative frequency of 0.33%. *Azadirachta indica* has the highest density per hectare of 103.33; followed by *Acacia tortilis* 118.67; *Acacia auricuriformis* and *Acacia sieberiana* has density of 85.33 and 57.71 plants per hectare respectively. *Diospyros mespiliformis, Eucalyptus microcarpa, Ficus benjamina, Ficus platyphylla and Vitex doniana* has the lowest density of 4.00 plants per hectare. *Azadirachta indica*; *Acacia sieberiana*; *Albizia lebbeck*; *Acacia tortilis* recorded the highest relative density 30.097; 9.806; 8.41 and 8.641 respectively. While *Eucalyptus microcarpa*, *Vitex doniana*, *Ficus benjamina* and *Ficus platyphylla* has the lowest relative density in the study area. *Khaya senegalensis* and *Adansonia digitata* has the highest basal area of 24.435m and 6.326m respectively, while *Acacia auricuriformis* 0.001m, *Polyaithia longifolia* 0.002m and *Acacia tortilis* 0.009m respectively. *Khaya senegalensis* has the highest relative dominance of 55.69; followed by *Adansonia digitata* 14.419 and *Tectona grandis* 13.824. *Ficus benjamina, Acacia auricuriformis and Polyaithia longifolia* has the lowest value of relative dominance of 0.001; 0.002 and 0.004 respectively. Species richness value of 330.253 for the entire study area was recorded. Shannon weinner diversity index (H`) was 1.113. The summary of tree species distribution and diversity in the study area is presented in Table 4. A total of 35 tree species were encountered in Kano State Zoological Garden distributed in 15 families. The Shannon Weinner diversity index for the study area was 1.13 while species evenness is 0.160. Simpson`s index 0.001.

Table 1: Tree species composition, Families, Mean Height, Mean Diameter at Breast Height (dbh) and total number of individual species

Scientific name	Common name	Family	Mean H(M)	Mean D(M)	No. of indi.
Acacia auriculiformis	Northblack watte	*Fabaceae*	8.33	0.13	64
Acacia sieberiana	Paperback thorn	*Fabaceae*	12.75	0.45	101
Acacia tortilis	Umbrella thorn acacia	*Fabaceae*	8.25	0.23	89
Adansonia digitata	Boabab	*Malvaceae*	13.74	1.19	4
Albizia lebbeck	Lebbeck tree	*Fabaceae*	9.83	0.38	89
Annona squamosa	Sugar apple	*Annonaceae*	4.00	0.11	1
Azadirachta indica	Neem	*Meliaceae*	16.50	0.58	310
Balanite aegyptica	Desert date	*Zygophyllaceae*	8.00	0.35	12
Casuariana equisetifolia	Australian pine tree	*Casuarinaceae*	15.00	0.41	2
Ceiba pentendra	Silk cotton	*Malvaceae*	12.00	0.27	34
Dalberga sissoo	Norh rose wood	*Fabaceae*	23.25	0.70	50
Deloix regia	Flame ree	*Fabaceae*	20.25	0.71	12
Diospyrs mespiliformis	Jacka berry	*Ebenaceae*	6.00	0.11	1
Eucalyptus camaldulensis	Eucalyptus	*Myrtaceae*	22.17	0.78	10
Eucalyptus microcarpa	Grey box	*Myrtaceae*	30.00	0.78	1
Ficus benjamina	Weeping pig	*Moraceae*	4.00	0.11	2
Ficus platyphylla	Flake rubber tree	*Moraceae*	4.00	0.10	1
Ficus sycomorus	Sycomore fig	*Moraceae*	10.33	0.41	11
Gmelina arborea	Beech wood	*Lamiaceae*	24.14	0.68	23
Hyphaene thebaica	Doum palm	*Arecaceae*	11.00	0.48	1
Khaya senegalensis	Mahogany	*Meliaceae*	35.63	1.67	50
Leuaena leucocephala	White lead tree	*Fabaceae*	17.17	0.42	17
Mangifera indica	Mango	*Anacardiaceae*	14.00	0.42	9
Piliostigma reticulatum	Prota	*Fabaceae*	13.00	0.40	4
Polyaithia longifolia	Ashoka	*Annonaceae*	5.00	0.15	2
Senna siemia	Siamese cassia	*Fabaceae*	19.75	0.58	13
Syzygium guineense	Watter berry	*Myrtaceae*	16.00	0.40	63
Tamarindus indica	Tamarind	*Fabaceae*	11.33	0.67	3
Tectona grandis	Teak	*Lamiaceae*	23.75	1.18	5
Terminalia bellerica	Bahera	*Combretaceae*	18.50	0.47	5
Terminalia catappa	Country almond	*Combretaceae*	4.50	0.11	2
Terminalia mantaly	Mantaly	*Combretaceae*	5.85	0.11	6
Vachellia nilotica	Gum arabic tree	*Fabaceae*	9.83	0.26	26
Vitex doniana	Black plum	*Verbenaceae*	7.00	0.32	1
Ziziphus spina-christi	Christ`s thorn jujube	*Rhamnaceae*	7.00	0.33	6
Total					**1030**

Table 2: Relative Density of the Families encountered in the study area

Families	Relative density (%)
Fabaceae	44.56
Meliaceae	21.75
Moraceae	4.21
Myrtaceae	7.02
Zygophyllaceae	1.40
Malvaceae	4.21
Rhamnaceae	2.11
Annonaceae	1.05
Combrataceae	4.56
Laminaceae	4.56
Anacardiaceae	2.81
Verbenaceae	0.35
Casuarinaceae	0.70
Ebenaceae	0.35
Arecaceae	0.35

Table 3: Species Frequency; Relative frequency; Density per hectare; Relative density, Basal area distribution; Relative dominance; Important value index; Species richness and Diversity of trees in Kano State Zoological Garden.

Spp names	F	RF	D/ha	RD	BA	RDO	IVI	SR	-PilnPi
Acacia auriculiformis	25.000	2.500	85.333	6.214	0.001	0.002	8.715	20.911	-0.075
Acacia sieberiana	58.333	5.833	57.714	9.806	0.123	0.281	15.920	33.191	-0.099
Acacia tortilis	25.000	2.500	118.667	8.641	0.009	0.020	11.161	29.208	-0.092
Adansonia digitata	25.000	2.500	5.333	0.388	6.326	14.419	17.308	0.996	-0.009
Albizia lebbeck	100.000	10.000	29.667	8.641	0.067	0.152	18.793	29.208	-0.092
Annona squamosa	8.333	0.833	4.000	0.097	0.000	0.000	0.931	0.000	-0.003
Azadirachta indica	100.000	10.000	103.333	30.097	0.366	0.834	40.931	102.561	-0.157
Balanite aegyptica	16.667	1.667	24.000	1.165	0.047	0.107	2.939	3.651	-0.023
Casuariana equisetifolia	8.333	0.833	8.000	0.194	0.085	0.193	1.220	0.332	-0.005
Ceiba pentendra	25.000	2.500	45.333	3.301	0.016	0.036	5.837	10.953	-0.049
Dalbergia sissoo	58.333	5.833	28.571	4.854	0.754	1.719	12.407	16.264	-0.064
Delonix regia	41.667	4.167	9.600	1.165	0.787	1.794	7.126	3.651	-0.023
Diospyros mespiliformis	8.333	0.833	4.000	0.097	0.000	0.000	0.931	0.000	-0.003
Eucalyptus camaldulensis	16.667	1.667	20.000	0.971	1.163	2.650	5.288	2.987	-0.020
Eucalyptus microcarpa	8.333	0.833	4.000	0.097	1.133	2.583	3.514	0.000	-0.003
Ficus benjamina	16.667	1.667	4.000	0.194	0.000	0.001	1.862	0.332	-0.005
Ficus platyphylla	8.333	0.833	4.000	0.097	0.000	0.000	0.931	0.000	-0.003
Ficus sycomorus	50.000	5.000	7.333	1.068	0.089	0.202	6.270	3.319	-0.021
Gmelina arborea	16.667	1.667	46.000	2.233	0.686	1.563	5.463	7.302	-0.037
Hyphaene thebaica	8.333	0.833	4.000	0.097	0.160	0.365	1.295	0.000	-0.003
Khaya senegalensis	66.667	6.667	25.000	4.854	24.435	55.693	67.214	16.264	-0.064
Leuaena leucocephala	25.000	2.500	22.667	1.650	0.095	0.218	4.368	5.311	-0.029
Mangifera indica	33.333	3.333	9.000	0.874	0.098	0.223	4.430	2.655	-0.018
Piliostigma reticulatum	16.667	1.667	8.000	0.388	0.080	0.183	2.238	0.996	-0.009
Polyaithia longifolia	8.333	0.833	8.000	0.194	0.002	0.004	1.031	0.332	-0.005
Senna siemia	33.333	3.333	13.000	1.262	0.343	0.783	5.378	3.983	-0.024
Syzygium guineense	50.000	5.000	42.000	6.117	0.077	0.176	11.292	20.579	-0.074
Tamarindus indica	16.667	1.667	6.000	0.291	0.639	1.457	3.415	0.664	-0.007
Tectona grandis	16.667	1.667	10.000	0.485	6.065	13.824	15.976	1.328	-0.011
Terminalia bellerica	8.333	0.833	20.000	0.485	0.147	0.335	1.654	1.328	-0.011
Terminalia catappa	8.333	0.833	8.000	0.194	0.000	0.000	1.028	0.332	-0.005
Terminalia mantaly	25.000	2.500	8.000	0.583	0.000	0.001	3.083	1.660	-0.013
Vachellia nilotica	25.000	2.500	34.667	2.524	0.013	0.030	5.055	8.298	-0.040
Vitex doniana	8.333	0.833	4.000	0.097	0.031	0.070	1.001	0.000	-0.003
Ziziphus spina-christi	33.333	3.333	6.000	0.514	0.036	0.082	3.930	1.660	-0.013
Σ	**1000**	**100**	**837.219**	**99.932**	**43.875**	**100.000**	**299.932**	**330.253**	**1.113**

SPP Names= species scientific names, F =frequency, RF= Relative frequency, D/ha= Density per hectare, RD= Relative density, BA= Basal Area, RDO= Relative Dorminance, IVI= Important Value Index, SR= Species richness.

Table 4: summary of tree species diversity and distribution in Kano State Zoological Garden

Indices	NS	NF	H`	H/Hmax	D
Kano Zoo	35	15	1.113	0.160	0.001

NS= Number of species, NF= Number of families, H`= Shannon Weinner diversity index, H/Hmax= species evenness, D= Simpson`s index,

Trees density gives forester an idea of how closely trees are growing in a given area. The total numbers of individual trees in all the plots were 1030, while the numbers of tree species were 35 belong to 15 different families. I *Azadirachta indica* and *Albizia lebbeck* recorded as a species with highest relative frequency 10.00% while *Diospyros mespiliformis, Annona squamosa, Casuariana equisetifolia, Ficus platyphylla,and Hyphaene thebaica* has the same relative frequency of 0.33% respectively. Density per hectare of individuals' species were calculated, in which *Azadirachta indica* has the highest density per hectare with 103; followed by *Acacia tortilis* 118; *Acacia auricuriformis* and *Acacia sieberiana* has density of 85. and 57 plants per hectare respectively. *Diospyros mespiliformis, Eucalyptus microcarpa, Ficus benjamina, Ficus platyphylla and Vitex doniana* has the lowest density of 4.00 plants per hectare. According to Asish *et al.,* (2006) stated that tree density varies with forest community type, age, class, tree species, and size class and site conditions among others. *Azadirachta indica*; *Acacia sieberiana*; *Albizia lebbeck*; *Acacia tortilis* have the highest relative density 30.097; 9.806; 8.41 and 8.641 respectively. While *Eucalyptus microcarpa*, *Vitex doniana*, *Ficus benjamina* and *Ficus platyphylla* has the lowest relative density in the study area. *Khaya senegalensis* and *Adansonia digitata* has the highest basal area of 8.762m and 4.458m respectively, while *Diospyros mespiliformis, Ficus benjamina and Ficus platyphylla* had the lowest basal of 0.013m, 0.018m and 0.031m respectively. The differences in the basal area of trees studied could be due to differences in altitude, species composition, age of trees, and extent of disturbances and successional strategies of the stands. *Khaya senegalensis* has the highest relative dominance value 23.691; followed by *Adansonia digitata* 12.054 and *Tectona grandis* 11.803. *Diospyros mespiliformis; Ficus benjamina and Ficus platyphylla* have the lowest value of relative dominance. The *Fabaceae* and *meliaceae* families were the most abundant families in the study area which account for about 45% of the total families of trees in the Zoological garden, followed by *Meliaceae* 21.75%; *Myrtaceae* 7.02%; *Moraceae* 4.21, while *Zygophyllaceae, Annonaceae, Casuarinaceae, Ebenaceae* and *Arecaceae* has the lowest relative density respectively the variations in the families encountered in Kano state zoological garden could be attributed to the enrichment planting carried out to enhance the species composition of the garden in order to provide conducive environment in the garden for both animals and visitors

Tree species diversity, composition and richness in Kano State Zoological Garden

Typically, the Shannon in real ecosystem ranges between 1.5 and 3.5 (MacDonald, 2003). Considering the value (1.113) recorded in this study, Kano State Zoological Garden could not be considered as a species rich forest when compared with other tropical forest types. Since alots of deliberate anthrophogenic activities was conducted to introduce additional tree species and also at the same time remove the unwanted ones in order enhance the aesthetic beauty of the garden to accommodate more tourists. However, Onyekwelu *et al.,* (2007) obtained higher *H*` values of 3.12, 3.31 and 2.82 at Oluwa, Queen`s and Elephant Forests, respectively, in the tropical rain forest of Nigeria. Similarly in a research conducted by Jamala *et al.,* (2016) discovered 3.00 Shannon weinner diversity index in Nyibango forest grazing reserve. The low diversity or species richness recorded further confirms the differences across the region as influenced by the ecological and climatic variations. It was also reported that the patterns of species richness were the consequences of many interacting factors, such as plant productivity, competition, geographical area, historical or evolutionary development, regional species dynamics, regional species pool, environmental variables and human activity (Woodward, 1988; Palmer, 1991; Eriksson, 1996; Zobel, 1997). In terms of species distribution within the Zoological garden, some had few number species with large numbers of individuals and some had many species with few numbers of individuals. Species evenness (E_H) which is the measure of equitability of spread of available species was calculated (0.160) and considered to be fairly distributed due to less number of species within the Zoo. Other attributive factors to the distribution of trees resulted due to collection of food for the herbivores animals, felling of trees for the establishment of some infrastructures in the Zoological Garden as well as the soil physio-chemical properties influencing tree species richness and distribution within the Zoological Garden. Generally, Simpson index ranges from 0 to 1. Mature and stable communities have high diversity value (0.6 to 0.9), while the communities under stress conditions, exhibiting low diversity, usually show close to zero value (Dash, 2003). Simpson diversity index is always higher where the community is dominated by less number of species and when the dominance is shared by large number of species (Whittaker, 1965) in this study Simpson index in Kano Zoo was (0.001). The lower diversity associated with Kano State Zoological garden as ascribed by Shannon, and Simpson index could be attributed to lesser number of species which could be due to anthropogenic activities beside other biotic factors.

Conclusion

Conclusively, the information obtained from this study area clearly indicates the present floristic status of Kano State Zoological Garden (Density, Diversity and Distribution). Tree Species composition was ascertained. Result obtained indicated that Kano zoo is moderately dense, diverse and trees species were evenly distributed across the garden.

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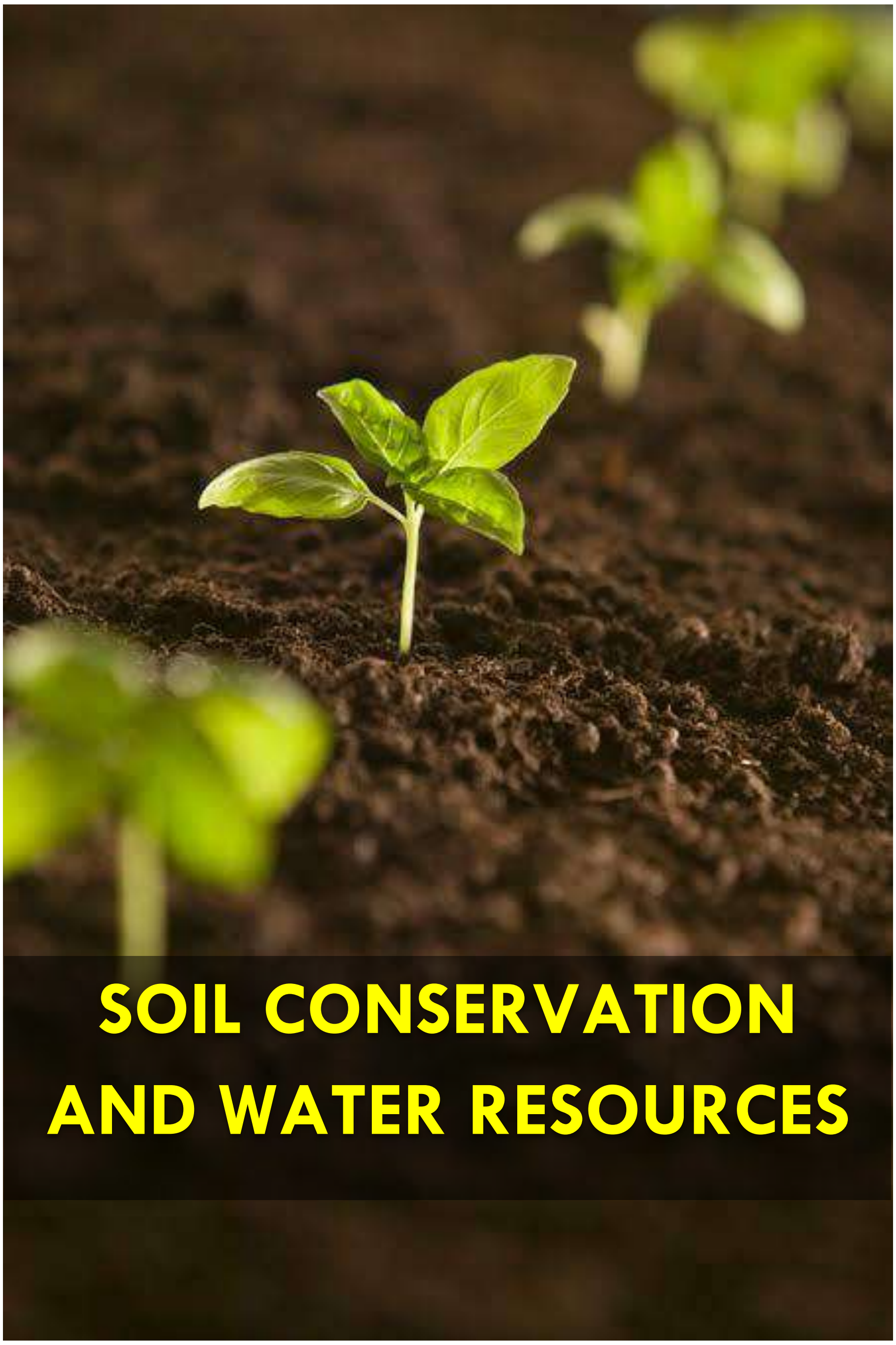
SUB-THEME 5



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Variability of Arable and Forest Topsoils in Ngor-Opkala, South-Eastern Nigeria

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Abstract
This research was carried out in Okpala community of Ngor-Opkala Local Government of Imo State, South-eastern Nigeria in order to study the variability of the topsoil physic-chemical properties of forest and arable soils. Samples were collected from each of the land-uses, labelled properly and subjected to laboratory analysis to compare the variability of topsoil physic-chemical properties. Results of physical properties showed a higher sand, clay and bulk density at the arable soils compared to their forest counterparts. Sand scored 86.56 and 84.96%; clay scored 8.72 and 5.32%, bulk density scored 1.27 and 1.37% all at the arable and forest soils respectively. However, silt and silt:clay ratio were opposite as silt scored 3.12 and 5.92%; silt:clay ratio scored 0.548 and 1.78 in arable and forest soils respectively. Organic carbon, organic matter and total N were all higher at the forest soils compared to the arable soils. Organic carbon, OM and TN recorded 1.115, 1.923 and 0.105% respectively at the arable soils and 1.400, 2.409 and 0.133% respectively at the forest soils. These results are due to the present land use of the investigated soils. Calcium was very low (<2.0 g/kg) at the cultivated arable soils and low (2-5 g/kg) at the forest soils. Magnesium was also low (0.5 – 1.5 g/kg) at it scored 1.26 and 1.47 g/kg in arable and forest soils respectively. Potassium was moderate (0.3-0.6 g/kg) scoring 0.38 and 0.519 g/kg in arable and forest soils respectively. Sodium (Na) was low (<0.1 g/kg) scoring 0.055 and 0.079 g/kg) in arable and forest soils respectively. Most of the investigated physic- chemical properties varied lowly in their coefficient of variations. The topsoil's of these soils especially the cultivated soils should be carefully managed for continual sustainability and productivity.
Keywords: Soil variability, arable and forest soils, soil properties and Southeastern Nigeria

Introduction
Spatial variation is a natural phenomenon in soil that measures the differences in physical and chemical properties of soil from one point to another, soil variation can either be of a small or wide range. It could also be linked to soil formation factors such as, parent materials, climatic (in terms of rainfall and temperature), the nature of landscape relief, other factors include biological and human activities (Ogunkunle 1987). Soil variability is therefore the changes that occur within the soil as a result of the reactions happening within it day in day out and from time to time (Olantunji and Ewetola 2015). Variation in soil properties imposed limitation on the potentiality of the soil and productivity status. The precision of agriculture depends on how much knowledge a farmer have on the soil in which he is working with for optimum production. The knowledge of spatial variability of soil physical and chemical properties is essential for optimum and sustainable agriculture (Wilding, 1985). Therefore, to have a better understanding on how nutrient resources and soil properties vary across land-uses had become the focal point of much ecological research (Obasi *et al.,* 2011). Spatial variability and distribution of nutrients in relation to site characteristics such as land use and other variables are critical rate of ecosystem process (Schimel *et al*., 1991; Townsend *et al*., 1995). Differences in soil properties occasioned by vegetation and land-use could be a result of variation in leaf type, root type, canopy size, decomposition rate of

plant debris, as well as presence of decomposers. These affect organic matter content of soils (Stutter *et al.,* 2004) and soil properties in space and time. Nepstad *et al*., 1994 noted definition of topsoil varies according to the focus, as well as national tradition. From a soil science perspective, topsoil is the surface plus subsurface mineral horizons (A, as well as E if present). Agronomically, the topsoil coincides with the plow layer. FAO/UNEP (1999) does not make a distinction between these two views: "The topsoil is the upper part of the soil, with the lower limit at 30 cm, or shallower if a root growth inhibiting layer is present above that depth." Fully developed forest soils are natural bodies with a vertical sequence of layers (FAO/ISRIC, 1990). At the top is an organic surface layer or "forest floor" (O horizon) with subdivisions of fresh, un-decomposed plant debris (Oi horizon, formerly called L); semi-decomposed, fragmented organic matter (Oe horizon, formerly called F) and humus; and amorphous organic matter without mineral material (Oa horizon, formerly called H). Below this surface layer is a mineral surface horizon (A); a subsurface mineral horizon often leached (E); a subsurface mineral horizon with features of accumulation (B horizon); a mineral horizon penetrable by roots (C); and locally hard bedrock (R). Agricultural soils associated with rangelands and grasslands often have similar vertical sequences. However, if they are being cultivated (arable land)-or have been in the past-they may lack the O horizon (unless peat soils are being used), and the A horizon may have been mixed with parts of the E and even the B horizon, resulting in a plow layer (Ap horizon). The B and/or C horizons may have been broken up by deep cultivation. The soils may have been so degraded by past human actions that they are no longer cultivatable. This study however investigated the variability of arable and forest topsoils in Ngor-Okpala, southeastern Nigeria for sustained soil use.

Materials and Methods

Study area

Ngor- Okpala is located in Imo State southeastern Nigeria lying within Latitudes: 5^{o}. 28’2 – 5^{o}.4’7’N and Longitudes 7.0’ 25” – 7.1’33” E. Ngor Okpala is a Local Government Area of Imo State, Nigeria. Its headquarters are in the town of Umuneke Ngor. It has an area of 561 km^2 and a population of over159,932. It connects Abia and Rivers states of Nigeria. It is the largest local government area in Imo State and one of the largest in Nigeria. The area belongs to the low lying part of southeastern Nigeria, and soils are derived from coastal plain sands and shale. Rainforest vegetation is dominant in the area while it has a humid tropical climate. Total mean annual rainfall is between 1800 and 2500 mm, and is bimodal. Mean annual temperature ranges from 26 to 30 °C. Low-input arable farming is the dominant socio economic activity in the area.The vegetation of Ngor-Okpala is tropical rainforest located in Southeastern Nigerian. The increased activities of man which include bush burning, hunting and farming have apparently converted major part of the original vegetation to secondary forest, savanna and arable soils.

Socioeconomic activities

The major occupation of the people of Ngor-Okpala is subsistence farming with food crops dominating the practice. The agricultural type is mainly the mixed farming where foods crops predominantly planted are cassava and yam. Mixed cropping of cassava with yam or other crops like vegetables is practiced. Generally, agricultural activities at the location are intense and soil information is needed to guide the subsistence farmers on the use of necessary inputs.

Field work

This research was carried out in Okpala community of Ngor-Opkala in order to compare the topsoil physic-chemical properties of forest and arable soils. five samples were collected from each of the land-uses given a total of ten samples for the forest and arable soils. Samples were labeled properly and subjected to laboratory analysis to compare the variability of topsoil physic-chemical properties.

Laboratory soil analysis

Soil samples were air dried, pulverized, and sieved through a 2 mm sieve mesh. The properties analyzed include particle size distribution determined by hydrometer method (Gee and Bauder, 1986). Soil pH was determined in a 1:1 soil/water ratio using digital pH meter and conductivity meter respectively. Exchangeable acidity was determined by the 1N KCl method. Exchangeable basesincluding calcium (Ca), magnesium (Mg), potassium (K), and sodium (Na) were determined using NH_4OAc saturation method (IITA, 1979). Calcium and Mg in solution were determined using Atomic Absorption Spectrophotometer, while K and Na were determined using Flame Emission Photometer. Organic carbon was determined by Walkley and Black dichromate wet oxidation method (Nelson and Sommers,1982). Total nitrogen was determined by micro-kjeldahl technique (Bremner and Mulvaney, 1982). The effective cation exchange capacity (ECEC) was determined by summation method, while the available phosphorus was extracted by Bray II method (Olsen and Sommers 1982).

Statistical Analysis

Coefficient of variation (CV) was used to estimate the degree of variability existing among soil properties in the study site. Coefficient of variation was ranked as low variation ≤15%, moderate variation >15≤35%, high variation >35% was used as outlined by Wilding, (1985). Also, soils were subjected to analysis of variance according to Wahua 1999.

Results and Discussion

The physical properties of the studied soils are as shown in table 1. Arable soils were represented with A1 – A5 while Forest soils were represented with F1 – F5. Sand had means of 86.56 and 84.96% in arable and forest soils respectively. Mean silt and clay were 3.12 and 5.93% for silt, 8.72 and 5.32% for clay in arable and forest soils respectively. The higher content of mean sand in the arable soil compared to its forest counterpart may be due to the regular disturbances of the arable soils for cultivation purposes leading to the disintegration of the soil structure. Clay particles as well as some other soils minerals therefore travel further down into the subsoil through eluviation and illuviation processes. Further disturbance of the cultivated topsoils may have created granulated particles which constitutes more of clay than silt when compared to the forest counterparts. This may be the reasons why the forest soils had more mean silt than the cultivated soils and vice versa in sand and clay components of the investigated soils. Mean silt:clay ratio was higher in forest (1.78) soil when compared to the cultivated (0.548) soil suggesting a higher weatherebility of the arable over the forest soils. The mean bulk density of the arable soils is higher (1.27 g/cm^3) compared to that of the forest (1.13 g/cm^3) counterpart. This may be attributed to the higher sand content of the arable soils compared to the forest soils. Also, it is expected that due to use of the arable soils for crops cultivation, organic matter content would have depleted significantly giving room to higher bulk density.

The forest soils as expected have deposits of litter which decomposes to form organic matter. This organic matter mix p with the topsoil's as well as providing much of the needed nutrients constituents of these soils. This invariably reduces the topsoil bulk density of the forest soils. However, the bulk densities of the studied soils were all within the acceptable bulk density limits (<1.65) of tropical soils (USDA-NRCS 2016). Esheri *et al.,* (2017) noted that bulk density affects some key processes in the soil such as infiltration and microbial activities which in turn influence key soil pedogenic processes as well as productivity. The investigated Chemical properties of the studied soils are as shown in table 2. Soil pH recorded a moderately acidic condition in both arable and forest soils having means of 5.71 and 6.09 for arable and forest soils respectively.

Table 1: Physical Properties of soils

Location	Sand	Silt %	Clay	S:C ratio	TC	B.D g/cm3	Porosity
A1	82.96	4.72	12.32	0.383	LS	1.25	52.83
A2	86.96	2.72	10.32	0.263	LS	1.20	54.72
A3	92.96	2.72	4.32	0.629	S	1.22	53.96
A4	90.96	2.72	6.32	0.43	S	1.36	48.68
A5	90.96	2.72	6.32	0.43	S	1.36	48.68
Mean	86.56	3.12	8.72	0.548		1.27	52.08
F1	88.96	4.72	6.32	0.746	S	1.08	59.24
F2	84.96	6.72	8.32	0.807	LS	1.10	58.49
F3	88.96	6.72	4.32	1.555	S	1.06	60.0
F4	78.96	4.72	6.32	0.746	LS	1.19	55.09
F5	82.96	6.72	1.32	5.090	LS	1.2	54.72
Mean	84.96	5.92	5.32	1.78		1.13	57.51

A1-A5 = Arable soils, F1 – F5= Forest soils, S:C Ratio = Silt: Clay ratio, TC = Textural class, B.D= bulk density

Cropping activity and leaching due to high rainfalls may have affected the basic cations of the arable soils thereby causing the exchange complex to be dominated by more acidic cations when compared to the forest soils. Similar pH result have been documented by Okoli et al., (2017). This pH result is within the pH requirement (5.5 – 6.5) for tropical soils productivity and soil sustainability. Organic carbon, organic matter and total N were all higher at the forest soils compared to the arable soils. Organic carbon, OM and TN recorded 1.115, 1.923 and 0.105% respectively at the arable soils and 1.400, 2.409 and 0.133% respectively at the forest soils. These results are due to the present land use of the investigated soils. Organic carbon and OM of the arable soils may have depleted due to cultivation activities whereas that of the forest soils were rather being built up due to litter accumulation from forest trees. The results of organic matter and total N obtained indicated low at the arable soils and medium at the forest soils when the critical limits were considered (Obasi et al., 2015). Available Phosphorus, basic and acidic cations, total exchangeable acidity (TEA), total exchangeable bases (TEB) and effective cation exchange capacity (ECEC) were all higher in their mean values at the forest soils when compared to their cultivated counterparts. Available P scored 24.27 and 34.21 mg/kg at the arable and forest soils respectively. TEA scored 0.92 and 1.45 g/kg, TEB scored 2.743 and 4.091 g/kg while ECEC recorded 3.66 and 5.537 g/kg all in arable and forest counterparts respectively. Critical limits (Tabi *et al.,* 2012, Obasi *et al.,* 2015) revealed that available P was high (>15 mg/kg) in arable and forest soils which scored 24.27 and 34.21 mg/kg respectively. Calcium was very low (<2.0 g/kg) at the cultivated arable soils and low (2-5 g/kg) at the forest soils. Magnesium was also low (0.5 – 1.5 g/kg) at it scored 1.26 and 1.47 g/kg in arable and forest soils respectively. Potassium was moderate (0.3-0.6 g/kg) scoring 0.38 and 0.519 g/kg in arable and forest soils respectively. Sodium (Na) was low (<0.1 g/kg) scoring 0.055 and 0.079 g/kg) in arable and forest soils respectively. The mean scores of soil physic- chemical properties as well as coefficient of variation and Lsds were as presented on Table 3. Soil properties such as pH, OC, OM, TN, Available P, Ca, K, ECEC, Base saturation sand and bulk density all had low variation both at the arable and forest soils. Magnesium, H, TEA and TEB all varied moderately (MV) at the arable soils and lowly (LV) at the forest soils. Sodium exhibited moderate variation at the arable and forest soils. Aluminum and silt had high (HV) variation at the arable soils and moderate variation (MV) at the forest soils. Clay indicated high (HV) variation both at the arable and forest soils. Analysis of variance at the arable and forest soils indicated that OC, OM, TN, Ca, K, Na, H, TEB and ECEC were all highly significant at 0.01% level. Available P, Mg, TEA and Bulk density were significant at 0.05% level while Soil pH, Al, Base saturation, sand, silt and clay were non-significant (NS) at the arable and forest studied soils.

Table 2: Chemical Properties

Location	pH (H_2O)	OC	OM %	TN	Avail.P Mg/kg	Ca	Mg	K	Na	H g/kg	Al	TEA	TEB	ECEC	%BS
A1	5.82	1.105	1.905	0.105	26.28	1.31	0.93	0.326	0.007	0.73	0.29	1.02	2.573	3.593	71.61
A2	5.73	1.122	1.934	0.106	25.12	1.27	1.30	0.415	0.019	0.58	0.38	0.96	3.004	3.964	75.78
A3	5.89	1.069	1.843	0.101	28.62	1.22	1.05	0.318	0.01	0.62	0.62	1.24	2.578	3.838	67.69
A4	5.55	1.135	1.957	0.108	21.17	1.57	0.98	0.403	0.015	0.44	0.001	0.44	2.968	3.4081	87.08
A5	5.59	1.146	1.976	0.109	22.19	1.2	1.06	0.322	0.014	0.6	0.35	0.95	2.596	3.546	73.2
Mean	**5.71**	**1.115**	**1.923**	**0.105**	**24.27**	**1.31**	**1.26**	**0.38**	**0.055**	**0.59**	**0.32**	**0.92**	**2.743**	**3.66**	**75.07**
F1	6.28	1.421	2.45	0.135	36.05	2.15	1.46	0.521	0.103	1.13	0.44	1.57	4.234	5.803	72.96
F2	6.51	1.506	2.596	0.145	38.21	2.08	1.48	0.602	0.091	1.05	0.52	1.57	4.253	5.823	73.03
F3	5.93	1.322	2.279	0.125	29.55	1.92	2.00	0.513	0.082	0.92	0.41	1.33	4.515	5.845	77.24
F4	5.62	1.418	2.44	0.134	32.13	2.11	1.19	0.486	0.058	1.02	0.32	1.34	3.844	5.184	74.15
F5	6.11	1.322	2.279	0.125	35.11	1.85	1.22	0.477	0.061	0.86	0.56	1.42	3.608	5.028	71.75
Mean	**6.09**	**1.400**	**2.409**	**0.133**	**34.21**	**2.02**	**1.47**	**0.519**	**0.079**	**1.00**	**0.45**	**1.45**	**4.091**	**5.537**	**73.83**

A1-A5 = Arable soils replicate, F1-F5 = Forest soils replicate, OC= Organic Carbon, Av.P= Available Phosphorus, TEA= Total exchangeable acidity, TEB= Total exchangeable bases, ECEC= effective cation exchange capacity, %BS=percentage base saturation

Table 3: Means of Soil Physico- chemical Properties Showing Coefficient of variation and LSDs

Soil Properties	Arable Soils	CV (%)	Rank	Forest Soils	CV (%)	Rank	Lsd	Sig. Level (0.01, 0.05)
pH (H_2O)	5.71	5.6	LV	6.09	2.5	LV	0.3804	NS
OC (%)	1.15	5.6	LV	1.40	2.7	LV	0.0859	***
OM (%)	1.923	5.5	LV	2.409	2.7	LV	0.1479	***
TN (%)	0.105	6.3	LV	0.133	2.9	LV	0.0092	***
Avail. P (mg/kg)	24.27	9.9	LV	34.21	12.3	LV	4.70	**
Ca (g/kg)	1.31	11.4	LV	2.02	6.4	LV	0.2042	***
Mg (g/kg)	1.26	22.1	MV	1.47	13.4	LV	0.3657	**
K (g/kg)	0.38	13.4	LV	0.519	9.5	LV	0.0710	***
Na (g/kg)	0.055	35.7	MV	0.079	24.5	MV	0.0205	***
H (g/kg)	0.59	17.5	MV	1.00	10.7	LV	0.1537	***
Al (g/kg)	0.32	67	HV	0.45	21	MV	0.2489	NS
TEA (g/kg)	0.92	31.9	MV	1.45	8.2	LV	0.3266	**
TEB (g/kg)	2.743	17.6	MV	4.091	8.8	LV	0.3467	***
ECEC (g/kg)	3.66	7.2	LV	5.537	6.2	LV	0.471	***
BS (%)	75.07	9.8	LV	73.83	2.8	LV	7.86	NS
Sand (%)	86.56	6.6	LV	84.96	5.0	LV	7.35	NS
Silt (%)	3.12	73.4	HV	5.92	18.5	MV	3.747	NS
Clay(%)	8.72	50	HV	5.32	38.1	HV	5.85	NS
BD (g/cm^3)	1.27	4.1	LV	1.126	5.7	LV	0.0863	**

OC= Organic Carbon, Av.P= Available Phosphorus, TEA= Total exchangeable acidity, TEB= Total exchangeable bases, ECEC= effective cation exchange capacity, %BS=percentage base saturation. LV= low variation, MV = moderate variation, HV = high variation.

Conclusion

The studied soils showed that pH was within the pH requirement (5.5 – 6.5) for tropical soils productivity and soil sustainability. Critical limits revealed that calcium was very low (<2.0 g/kg) at the cultivated arable soils and low (2-5 g/kg) at the forest soils. Magnesium was also low (0.5 – 1.5 g/kg) at it scored 1.26 and 1.47 g/kg in arable and forest soils respectively. Analysis of variance at the arable and forest soils indicated that OC, OM, TN, Ca, K, Na, H, TEB and ECEC were all highly significant at 0.01% level. Careful management of these soils will ensure greater productivity and sustainability.

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Evaluation of Acidic Limed Soil in Combination with Nitrogen in Biosolids for Optimal Yam Production

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Abstract
The research work was conducted at the eastern farm of the National Root Crops Research Institute Umudike, Southeast agro-ecological zone of Nigeria in 2016 and 2017 cropping seasons to investigate the acidic limed soil in combination with nitrogen in Bio-solids to achieve a steady-state for optimal yam production. Initial sample of the soil was analyzed to determine the level of soil acidity, it revealed actually that the soil was acidic thereby phosphate becomes converted into insoluble iron phosphate. The risk of over liming was prevented to overcome phosphorous being converted into insoluble calcium phosphate. The design was randomized complete block design, replicated three times with a plot size of 5 x 5 = 25sq meter. Two different varieties were used which includes; D. rotundata and D. alata. Organic manure was used as nitrogen solids to achieve a steady state in the soil. Under state of lime application and inclusion of bio solids enabled mineralization to be obtained. Appropriate condition was achieved when the organic matter were added to limed soil which gave or resulted to ammonium and nitrate for effective output.

Introduction
The importance of lime stone is in its ability to neutralize soil acidity (Lurry, 2015). Chemically lime is calcium oxide (Cao) (Laura, 2011). In agriculture, lime is usually defined as calcium-magnesium containing compounds capable of reducing harmful effects of an acid soil by neutralizing soil acidity and raising the pH level. Manure nitrogen (N), in both organic and inorganic forms, inorganic (N), mostly ammonium ($NH^4 4$) and nitrate (No3), is really available to plants. Before organic N can be taken up, however, it must first be converted to inorganic forms. This process which is completed by soil microbes as a by-product of organic matter decomposition is called mineralization (David, 2004). Bryant (2013) reached that bio-solids are the nutrient rich organic materials from the treatment of sewage sludge and used in reclamation of agricultural forest and disturbed lands since the 1960s. The manure forage systems mineralization accounts for much or most of the crops needs. An understanding of the mineralization rate concept can help improve manure management to meet crop N demands while minimizing the potential for regulating concerns regarding ground water pollution (David, 2004). Organic manure are considered slow release nutrient sources so that potential for exceeding tree nutrient demands and associated environment contamination is likely reduced relative to synthetic fertilization. The uses of organic materials are often more cost effective and also promotes useful recycling (Bryant, 2013). When manure are regularly added to the soils, the organic N pool gradually increases over time until it eventually reached a plateau known as the steady-state condition (David, 2004). Indebt studies have demonstrated the value of compost and wood clip mulches applied to urban landscapes for improving soil quality and tree growth (Bryant, 2013).
(Bryant, 2013) confirmed that urban tree growth is affected by soil quality and many anthropogenic factors (e.g. pollution, management, disturbances). Compact and to soil removal associated with urban site development have immediate and dramatic negative impacts on soil quality specifically, these activities may strongly alter soil carbon (C) and nitrogen (N) pools. Consequently, soil organic matter (SOM) dynamics should be at the forefront of concerns of stewards of urban trees. The cations on the (cation exchange capacity) CEC of the soil particles are easily exchangeable with other cations and as result they are plant available. Thus the CEC of the

soil represent the total amount of exchangeable cations that the soil can adsorb (Quinne, 2007). Nitrogen mineralization is the process by which N is converted to plant- available inorganic forms. Soil regularly amended with organic wastes will accumulates organic N until they reach a steady-state condition; a concept useful for planning N management strategies (David, 2004). David (2004) had it that at a steady-state, the amount of manure organic N added in a given year will approximately equal the amount mineralized. The mineralization rate is therefore the rate at which organic N is made plant available. He concluded that several factors affect mineralization rates particularly by temperature so that release varies throughout the year a predictable pattern. An understanding of these patterns is necessary to match crop N demands with the plant available N in the soil. Cations are positively charged ions such as calcium (Ca^{2+}), magnesium (mg^{2+}), and potassium (K^{+}), sodium (Zn^{2+}) and copper (Cu^{2+}). The capacity of the soil to hold on to these cations called the cation exchange capacity (CEC). These cations are held by the negatively charged clay and organic particles in the soil through electrostatic forces (negative soil particles attract the positive cations (Quinne Kettering, 2007). Mineralization is a function of temperature, moisture, soil texture and manure characteristics, elevated temperature, dramatically accurate decay. A rule of thumb is that decay rate double for every 18 of microbes live in a film of moisture on soil particles. Too little moisture deprives them of their habitat, while too much can block needed oxygen from infiltrating into the soil as can vary timely textured soils which tends to drain slowly (David, 2004).

The manures that contain bedding materials or that are otherwise rich in carbon can temporarily immobilize nitrogen from the soil, delaying its release to plant available forms. As microbes decompose carbon, they use the liberated energy to grow and reproduce. Nitrogen is a temporary phenomenon; it has a short-term (a few weeks or month) rather than a long term impact on soil fertility (David 2004). Before organic N can be taken up .by plant, however, it must first be converted to inorganic forms. This process, which is completed by soil microbes as a byproduct of organic matter decomposition is called mineralization. This means that the actual CEC of the soil will depend on the pH of the soil. Given the same amount and type of organic matter, a neutral soil (pH ->) will have a higher CEC than a soil with e.g. pH 5 or in other words, the charge will increase with; an increase in pH. Sandy soil low in organic matter have a very, low CEC (less than 3cmol.kg) while heavier clay soils or soils high in organic matter generally have a much higher CEC (greater than 20cmol/kg). The main objective of this study is the evaluation of acidic limed soil in combination with nitrogen in bio solids to achieve a steady -state for optimal yam production. Specific objectives of the study are: To determine whether it perform the duty of supporting the plant growth effectively, To determine whether it eradicate the antagonism in plant nutrients deficiency and To determine the best optimal weight that will give the best production.

Methodology

Research Area

The experimental plots were established in the eastern farm of National Root Crops Research Institute Umudike in 2016 and 2017 respectively. It is RCBD and it is replicated 3times the plot size is 6 x 5 = 30 sqm^{2}. Due to constant cropping the soil was discovered to be acidic which range between 5.30-5.70 pH level.

Treatment Allocation

The lime application took place on the 3/6/2016. The lime application was allowed for a period of time to permeate into the soil. The field marking was followed by and planting which took effect on the 6/6/2016. In 2017 planting was carried out on the 5/6/2017. The following varieties were used; Agba ocha, Ame, Hambakroasi for white yam. The following *D. alata* were used for the trial, they includes Um680, 89/01166 and Gborogboro. The organic matter was applied 8 weeks after planting and all the cultural routine management were observed at the right time.

Statistical Analysis

The harvesting took place on the 5/12/2017. The result was analyzed with analysis of variance (ANOVA) with genstat edition 3 discovery method and significant mean separated with LSD at 5% alpha level.

Results and Discussion

Table 1 illustrates the effect of bio solids on limed soil to obtain a steady state and achieve optimal production of *D. rotundata* and *D. alata* with equal weight of the planting size. Agbaocha, Ame and

Hambakwasi were used for *D. rotundata* while Um680, 89/01166 and Gborogboro were used for *D. alata.* The planting size was l00gm weight across the board. In 2016, the mean weight value for Agbaocha was 11.8kg, Ame weighed 16.9kg while Hamabakwasi resulted gave 27.8kg; the least significant difference of the mean was 7.77. In 2017 the mean value for Agbaocha was 20.6kg; Ame gave 12.6kg while Hambakwasi was 21.67kg. The LSD for 2017 stood at 13.06 alpha level. In 2016 both Ame and Hambakwasi were quite significant, while Agbaocha was insignificant. In aspect of *D. alata,* the following species were used which includes; Um680, 89/01166 and Gborogboro. In 2016, the total mean weight for Um680 stood at 10.73kg, 89/01166 stood at 14.07kg and Gborogboro at 16.23 and the LSD at 5.017 alpha level. In .the 2017, Um680 gave 15.47kg, 89/01166 resulted to 24.43kg and Gborogboro was 23.23kg. In 2016 the result of the analysis indicated that Agbaocha was insignificant with LSD at 1.810 with a mean value of 11.80kg. For Ame and Hambakwasi, they were quite significant with mean weight value of 16.87kg for Ame and LSD at 3.729 while Hambakwasi was 27.83kg at LSD at 5.72. In 2017 the analysis indicated insignificant difference. It shows that improvement increase with respect to Agbaocha will definitely improve the status of Agbaocha production and yam generally.

Table 1: The Effect of Biosolids on Limed Soil

Cropping season Treatment	Weight of planting size	*D. rotundata* 2016 mean value (kg)	2017 mean value (kg)	Treatment	*D.alata* weight panting size	2016 mean value (kg)	2017 mean value (kg)
Agba ocha	100gm	11.8	20.6	Um680	100gm	10.73	15.47
Ame	100gm	16.9	12.6	89/01166	100gm	14.07	24.43
Hambakwasi	100gm	27.8	21.67	Gborogboro	100gm	16.23	23.23
LSD		7.77	1.306	LSD		5.077	4.261

Conclusion

A stable condition was created that limited the presence of the soluble state of Al and Fe, and liming state that necessitates phosphorous converted into insoluble calcium sulphate was addressed. A reliable balance steady state was derived, with the addition of the organic manure into the limed soil function able temperature, moisture, soil texture and "manure characteristics which accelerated the decay of the organic matter response were achieved. Total output increased which indicates a satisfactory outcome without any inclusion of in-organic fertilizer. The vegetative influx could be attributed to absence of carbon and consistent presence of nitrogen with mineralization achieved.

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Assessing the Impact of Super GRO (Ethoxylated, Alkylphenol, Polysiloxane) in Combination with Acidic Limed Soil for Growth and Yield of Yam

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Abstract
In this study, initial lime application was carried out to bring down the acidic state of the soil to a pH level that will grant alkalinity. There was application of a super GRO both on the soil and aerial surface of the plants. The super GRO acted as an adjuvant, wetting agent and synergism. As an adjuvant, it is a multiple mixtures containing lead arsenate aims at decreasing the injury of the mixture to the plant through the addition of corrective, as in the case of lime added lead arsenate-lime sulfur combination or the increase in the efficiency of the mixture through the use of wetting, spreading, or sticking agents. While wetting agents, implies act by lowering the surface tension of water in which they are dissolved, they are substances in which there is a long-chain grouping in the molecule combined with a highly water-soluble group are extremely efficient in lowering surface tension in solution and a synergism is the process of working to gather, is said to occur when two materials, give a greater physiological action when applied together than when applied separately. The area for the planting, comprise of a plot size of 6 x 5 = 30sqm² and ridge of 5 meters constitute a plot size for each yam cultivar. The composition is 10litres of water to 10mls of Super GRO base on recommendation. Super GRO supplemented for organic matter or in-organic fertilizer. The introduction of Super GRO assisted in the achievement of a steady state and which created a balance state in promotion of plant nutrient availability.

Introduction
Laura (2011) noted that lime is calcium oxide and in agriculture, lime is usually defined as calcium or calcium-magnesium containing compound capable of reducing harmful effects of an acid soil by neutralizing soil acidity and raising the soil pH. He defined acidity to mean when there is presence of hydrogen ions dissolved in soil solution (water in the soil) and held on the clay and humus particles. pH. Is a measure of the degree of acidity or alkalinity. A value below 7.0 is acid, 7.0 is neutral and above 7.0 is alkaline. As the soil become more and more acidic (Laura, 2011). One the aspect of nutrient imbalance, some nutrient which supports plant growth does not act independently of one another. They function together and so necessary balance of given nutrient in relation to the other is very important. Too much or too little of a given nutrient may adversely affect the uptake of another. Nutrient imbalance is one of the concerns of soil fertility investigation. In order to make nutrient available, we need omniactivator that act as both an adjuvant and surfactant by reducing the surface tension of water in addition to acting as welting agent. With the introduction of hydrocarbon super GRO (Ethoxylated-Alkylphenol, polysilocane) will assist in the manipulation of the ecosystem in a way to maintain the soil fertility and optimal productivity. In order to make nutrient available, we need omniactivator that act as both an adjuvant and surfactant by reducing the surface tension of water in addition to acting as a welting agent. With the introduction of ethoxylation-alkylphenol and polysiloxane will assist in the manipulation of the ecosystem in a way to maintain the soil fertility and optimal productivity. The main objective of this study is accessing the impact of Super GRO (ethoxylated, alkylphenol, polysiloxane) in combination with acidic limed soil for growth and yield of yam.

Methodology

Study Area

The trial was conducted in eastern farm of National Root Crops Research Institute Umudike in 2016 and 2017 programme of activities in yam programme. It is RCBD and it is replicated 3 times. Pre-cropping soil analysis was carried out for every year planting. In the soil analysis conducted it showed that the soil was acidic with a pH level of 5.30 – 5.70.

Treatment Allocation

The land preparation was followed by application of lime and allowed to permeate in the soil. The following cultivars were used for the experiment which include; *D. rolundata* of the various varieties, Agba-ocha, Ame, Hambakwasi while the following *D. alata* were used for the trial they include Um680, 89/01166 and Gborogboro. The area for the planting, comprise of a plot size of 6 x 5 = 30 sqm^2 and each ridge of 5metres constitute a plot size for each yam cultivar of 50gms 100gms, 150gm and 250mgs weight. The yams were planted from 10/6/2016 to 2nd of June 2017. The applications were both on the floor and aerial with a composition is 10 litres of water to 10mls of Super GRO base on the recommendation of GND Int (PTY) LTD, South Africa.

Statistical Analysis

The first weeding was carried out 8 weeks after planting, followed by the necessary applications. The harvest took place on the 20/1/17 and 4/12/17 for the two planting years respectively. The yield were subjected to analysis of variance (ANOVA) by the use of genstat discovery edition 3 and means were separated with LSD and Duncan Multiple Range Test at 5% alpha level.

Results and Discussion

The results in Table 1 show a mean weight of *D. rotundata* grown in 2016 and 2017 with three major species of different sizes (50 gm, 100 gm, 150 gm, 200 gm, 250 gm). From the result, it can be observed that Agbaocha had the lowest mean yield weight in 2016 which was 2.71 kg, followed by Ame which had 3.79kg and the highest yield for Hambakwasi with a mean weight of 5.57kg. The means of the 3 species do not differ significantly from each other (P ≥ 0.05).

Table 1: Effect of veriety and weight of planting size in the application of super GRO on *D. rotundata* during 2016 and 2017 planting seasons

2016			2017		
Variety	**Weight of planting size (gms)**	**Total yield weight for 2016 (kg)**	**Variety**	**Weight of planting size (gms)**	**Total weight yield for 2017 (kg)**
Agba ocha	50	1.37	Agba ocha	50	4.97
	100	5.27		100	9.67
	150	1.80		150	9.13
	200	2.03		200	9.90
	250	3.07		250	11.63
Total mean		2.71^a			9.06^a
Ame	50	4.03	Ame	50	5.23
	100	3.47		100	6.80
	150	1.33		150	7.43
	200	3.73		200	7.37
	250	6.37		250	8.33
Total mean		3.79^a			7.03^a
Hambakwasi	50	2.87	Hambakwasi	50	6.53
	100	7.47		100	7.07
	150	3.80		150	9.20
	200	8.40		200	8.53
	250	5.33		250	8.70
Total mean		5.57^a			8.01^a
$LSD_{0.05}$ – (A)		4.216	$LSD_{0.05}$ (A)		2.408
$LSD_{0.05}$ (B)		3.532	$LSD_{0.05}$(B)		1.614^{***}
$LSD_{0.05}$(AxB)		6.284	$LSD_{0.05}$(AxB)		3.095

Table 2: Effect of variety and weight of plant size in the application of super GRO on *D.alata* during 2016 and 2017 planting season

2016			2017		
Variety	**Weight of planting size (gms)**	**Mean total weight yield for 2016 (kg)**	**Variety**	**Weight of planting size (gms)**	**Total weight yield for 2017 (kg)**
UM 680	50	7.30	UM 680	50	3.33
	100	9.00		100	5.37
	150	8.20		150	4.57
	200	6.60		200	5.60
	250	6.97		250	4.60
Total mean		7.61	Total mean weight		4.69
87/01166	50	13.80	87/01166	50	4.10
	100	14.20		100	6.07
	150	18.60		150	5.50
	200	9.93		200	8.00
	250	21.70		250	7.87
Total mean		15.65	Total mean weight		6.31
Gborogboro	50	5.43	Gborogboro	50	4.27
	100	8.30		100	6.03
	150	13.33		150	12.47
	200	12.37		200	9.87
	250	12.30		250	12.73
Total mean weight		10.35	Total mean weight		6.31
$LSD_{0.05}$ (A)		3.579		$LSD_{0.05}$ (A)	4.460
$LSD_{0.05}$ (B)		3.368		$LSD_{0.05}$ (B)	2.518
$LSD_{0.05}$(AxB)		5.822		$LSD_{0.05}$ (A xB)	5.229

In Table 2 which was comprised of Um680, 89/01166 and Gborogboro, it illustrates the performance of *D.alata* for 2016 and 2017 planting season. In 2016, the highest yield, stood at 89/01166 with a total mean weight yield 15.65 kg followed by Gborogboro with a total mean weight yield of 10.35kg and UM680 with a total mean weight yield of 7.61 kg. In 2016, the planting size of 250gms for 89/01166 out yielded every other species with a mean weight yield of 21.70 kg followed by 150gm also for 89/01166 with mean weight yield of 18.60kg and lastly Gborogboro with 13.33kg using planting size of 150 gms.

Table 3: Effect of Super Grow yield on the mean weight of *D. rotundata* (white yam)

Varieties	Weight of planting size	Total yield weight (kg)	Std. Deviation
Agba ocha	50 g	3.1667	0.42525
	100 g	7.4667	1.40119
	150 g	5.4667	1.50444
	200 g	5.9667	0.07638
	250 g	7.3500	1.92938
	Total	**5.8833[a]**	**1.94438**
Ame	50 g	4.6333	1.38684
	100 g	5.1333	0.51316
	150 g	4.3833	1.11841
	200 g	5.5500	1.74141
	250 g	7.3500	0.97340
	Total	**5.4100[a]**	**1.49728**
Hambakwasi	50 g	4.7000	1.46544
	100 g	7.2667	2.40069
	150 g	6.5000	2.08806
	200 g	8.4667	5.23673
	250 g	7.0167	2.08347
	Total	**6.7900[a]**	**2.81191**
$LSD_{0.05}$ (A)		**1.820*** **	
$LSD_{0.05}$ (B)		**2.350****	
$LSD_{0.05}$ (A xB)		**4.071**	

Table 3 shows the mean and standard deviation of varieties of white yam treated with super GRO. From the result Ame irrespective of the tuber weight has the lowest yield at 5.410 kg, followed by 5.8833 kg of Agbaocha and the highest yield was recorded on Hambakwasi with mean of 6.79 kg.

Table 4: Effect of Super Grow yield on the mean weight of *D. alata* (water yam)

Varieties	Weight of planting size	Total yield weight	Std. Deviation
Um680	50 g	5.3167	0.27538
	100 g	7.1833	1.01283
	150 g	6.3833	1.63274
	200 g	6.1000	1.20000
	250 g	5.7833	0.50083
	Total	**6.1533[a]**	**1.09471**
89/01166	50 g	8.9500	2.12309
	100 g	10.1333	0.75719
	150 g	12.0500	0.73655
	200 g	8.9667	3.47035
	250 g	14.7833	4.66431
	Total	**10.9767[b]**	**3.29880**
Gborogboro	50 g	4.8500	1.14346
	100 g	7.1667	1.18145
	150 g	12.9000	5.33948
	200 g	11.1167	3.05464
	250 g	12.5167	1.74952
	Total	**9.7100[b]**	**4.11939**
$LSD_{0.05}$ (A)		**1.496**	
$LSD_{0.05}$ (B)		**1.932***	
$LSD_{0.05}$ (A xB)		**3.346**	

Table 4 shows the mean and standard deviation of varieties of water yam treated with super GRO. From the result, 89/01166 irrespective of the tuber weight has the highest yield at 10.9767 kg, followed by 9.71 kg for Gborogboro and the lowest yield was recorded on Um680, with a mean of 6.1533 kg.

Table 5: T-Test comparism of Season performance of mean yield of *D. rotundata* (whiteyam)

	Year	Mean	Std. Deviation	Sig. (2-tailed)
Seasons	2016	11.202	5.3264	
	2017	6.691	3.7499	0.00***

Table 6: T-test comparison of season performance of mean yield of *D. alata* (water yam)

	Year	Mean	Std. Deviation	Sig. (2-tailed)
Seasons	2016	4.022	3.8449	
	2017	8.033	2.2998	0.00***

This research focused on the boosting strength of super Gro and limed soil on the yield performance of three different varieties of *D. rotundata* and *D. alata*. The combination of this two soil treatments however successfully supported the growth of both white yam and water yam. This finding was, however, not different from the earlier report by Murwira and Kirchman (1993) who noted that combined application of organic and inorganic fertilizer had best influence on tuber characteristics of yams. From the result it was observed that among the *D. rotundata* varieties, Hambakwasi had the highest level of yield. This there confirms that the application of the lime and super Gro fertilizer was more effective on the varieties mentioned. This agrees with the report of Tschannen (2003) who reported that the combined effects of cultivar and manure treatment on the yield varied among the cultivars. Ezakwukpolo cultivar gave the highest tuber yield when treated with NPK fertilizer while Pepa cultivar gave the least under the same treatment but when organic manure was applied to Danacha, the yield was greater than where NPK fertilizer was applied. Similar in this research, 87/01166 and gborogboro had the greater yield and hence, can be said to be due to the effect of the lime soil and the fertilizer on the yield of *D. alata*. It was observed that there was effect of weight of tuber on the yield performance of the various varieties of white yam. Similarly tuber weight of 200g and 250g were generally best in yield performance which may further suggest that tuber weight lower that 200 g may not perform well even under pH control soil and fertilized soil. These two observations suggest that soil fertilization has the potential for improving yam production for early harvesting. Contrary, Akanbi *et al*. (2007) reported longer tubers under yam without fertilizer than fertilizer treatments. The mean tuber girth (cm) was not significantly influenced by fertilizer application. The poor performance of tuber of lower gram weight at harvest may suggest that with a lower weight tuber the soil treatment with super Gro and lime may not affect directly the yield of yam. This is in agreement with the fact that tuber yield was higher with fertilizer and organic manure, yet yields were high enough where no fertilizer or organic manure was applied evidently due to high native fertility of the soil (Asadu *et al*., 1998). Generally white yam grown in 2017 had better yield than that of 2016, while, water yam grown in 2016 had better yield than that of 2017. This may suggest that difference in yam species may affect the expected effect of super gro and limed soil.

Conclusion

For effective yam growth, result shows that as the planting size increases, the output continue to increase until it struck a balance, as from 200gms weight which signifies that for effective weigh yam production 200gms weight is quite appropriate. The Super GRO is efficient for yam production and could effectively substitute for organic manure to achieve balance steady state. It is important for the improvement of the farm land with the inputs to overcome the problem of soil acidity due to constant cropping and improve the soil fertility through addition of the Super GRO to enhance the maximum output of the land.

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Earthworm Activities as affected by Nitrogen Sources in an Ultisol of Southeastern Nigeria

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Abstract
Fertilization of soil is an attempt to balance the competition between plants and soil microbes for available soil nitrogen. Field experiments were conducted at the Teaching and Research Farm of the Abia State University, Umudike location, Nigeria, during the 2009 and 2010 cropping seasons to determine the effects of organic and inorganic nitrogen (N) sources on earthworm activities. The N sources, each applied at the rate of 120kgha-^{1} were urea (UR), sawdust (SD), poultry dropping (PD), Cow dung (CD), brewers' spent grains (BS), pig manure (PM) and combination of the entire organic N sources (CB). Applications of N sources improve earthworm activities when compared with the control (CT).Earthworm population, biomass, cast number and cast weight were all significantly higher (p = 0.05) for the poultry dropping treatment when compared with the other treatments. On the other hand, earthworm population and biomass were lowest for the urea treatment with values of 2.3 /m^{2} and 0.14 g/m^{2} respectively, while cast number and weight were lowest (8.0 /m^{2} and 21.89 g/m^{2} respectively) for the control treatment.
Keywords: Earthworm activities, nitrogen sources and ultisol

Introduction
Soil is not a dead mass but an abode of millions of organisms, which includes crabs, snails, earthworms and others. Organisms, both plants and animals are important in the soil and nutrients can be added into agricultural soil through important biological processes. By creating channels through hardpans and unstructured soil, earthworms may help plant roots to penetrate deeper into the soil, since roots tend to follow the pathways of least resistance (Logsdon and Linden, 1992). Most earthworms that dwell in the soil rearrange it to suit their needs, creating different kinds of physical structures such as burrows, chambers for aestivation or cocoon deposition and casts. Through their feeding and casting activity earthworms affect both aggregate size and stability (Mackay and Kadivko, 1985). They also affect infiltration rate of a soil through their burrowing action. In soils where earthworms are active, the soil surface configuration is generally uneven and fragmented as a result of cast deposition and burrow openings. Nitrogen is in the atmosphere, soils and biological material of the terrestrial environment. In agricultural soil, mineralization of N by soil microbes is a most important process (Boyes*et al.,* 2011). Therefore, it is the soil microbial population which controls the productivity of these soils if environmental factors are suitable. Nitrogen tied up (assimilation) in microbial cells is not available for plants and other microbes until that tissue has been decomposed by other microbes. Also reported, is that microbial biomass is a reliable pool of OM and thus serves as an important reservoir of plant nutrients such as N, P and S. There has been increase in recent years in managing earthworms to improve crop production and offset soil degradation (Baker *et al*., 1996). These studies have shown that the earthworm activity of all species is beneficial for the soil environment as well as crop growth and yield while others showed no effect (Temple smith *et al.,* 1993) and others showed decreased plant growth (Double *et al.,* 1997*).* Several studies on the use of biological wastes for improving the productivity of fragile soils have been carried out in the tropics. Mbagwu (1989) compared the effectiveness of inorganic fertilizers and cattle feed-lot manure, rice husks, poultry manure and sawdust in improving subsoil productivity under greenhouse condition. Brewers'

spent grain (BS) organic manure produced highest grain yield of maize and cowpea when compared with other organic manures used in the study and was attributed to high earthworm activity (Njoku, *et al*., 2011). These studies attempted to find ways of utilizing these waste materials so as to minimize the disposal problems associated with them. Therefore, the objective of this study is to determine the effects of different nitrogen sources on earthworm activities in Southeastern Nigeria.

Materials and Methods

Field experiment to examine the effect of nitrogen sources on earthworm activities in maize – cowpea rotation cropping in an ultisoil in southeastern Nigeria was conducted at Abia State University, Umuahia Campus Teaching and Research Farms in 2009 – 2010. Abia State is located at (5^0 25'N and 7^0 35'E) in the rainforest ecological zone of Southeastern Nigeria. The area lies at about 129 m above sea level as measured with hand held global positioning (Garmin, Ltd. Kansas, USA).The climate of the area is humid tropical and supports the lowland rain forest vegetation. It is characterized by two distinct seasons – the wet season from April to October and the dry season from November to March. The mean annual rainfall ranges between 1900 - 2000mm. The experimental design was randomized complete block (RCB) replicated three times. Maize (*Zea mays L. Var.hybrid supper Oba* - 2) was planted during raining season. Cowpea (*Vignaunguiculata L. var. IR* – 48) followed after harvesting of maize during dry season. The treatments were control (CT), urea (UR), sawdust (SD), poultry dropping (PD), cow dung (CD), brewer's spent grain (BS), pig manure (PM), combination of all the organic manure (CB) and were applied at the recommended rate of 120 kg N ha^{-1} for maize in the Southeastern Nigeria. The organic nitrogen sources used were chemically analyzed (Table 1) and were cured for 10days. First weed control was done by spraying herbicides immediately after planting of maize and cowpea respectively. Subsequent weed control was done by hoe weeding as was necessary. Earthworm cast and earthworms were collected after cowpea harvest in all the plots in 7days to determine earthworm population, earthworm biomass, earthworm cast number and earthworm cast weight. Composite soil sample was collected after cowpea harvest. Thus, data collected were subjected to standard statistical analysis of variance (ANOVA). Treatment means were separated using least significance difference (LSD) at 5% level of probability test. Data were also subjected to linear regression and correlation analysis using SAS (1996) package.

Table 1: Some chemical properties of the nitrogen sources used in the study

Nitrogen sources	(%)				
	N	Ca	Mg	K	Na
Pig dung (PM)	1.47	0.52	0.05	0.27	0.19
Poultry dropping (PD)	1.57	1.20	0.05	0.40	0.31
Brewers' spent grains (BS)	5.95	0.90	0.30	0.05	0.28
nSawdust (SD)	0.28	0.70	0.18	0.28	0.08
Cow dung (CD)	1.30	0.48	0.07	0.28	0.78
Urea (UR)	46.6	-	-	-	-

Results and Discussion

Mean effects of nitrogen sources on earthworm population and earthworm cast number sampled after cowpea harvest in 2009 and 2010 are shown in Table 2. As indicated in Table 2, earthworm population, earthworm biomass, earthworm cast number and earthworm cast weight were all highest under PD treatment. Mean values for two years, the treatment was earthworm population (4.9 /m^2), earthworm biomass (0.68 g/m^2) earthworm cast number (13.3 /m^2) and earthworm cast weight (49.05 g/m^2). On the other hand, mean values of earthworm population and earthworm biomass were lowest under UR treatment with values of 2.3 /m^2 and 0.14 g/m^2 respectively, while mean values of cast number and cast weight (8.0 /m^2 and 21.89 g/m^2 respectively) recorded for the CT treatment. Mean values of earthworm population measured in 2009 and 2010 were of the order PD > SD > CD = PM > CB > CT > BS > UR, while mean values of worm biomass were of the order PD > PM > BS = CB > CD > SD > CT > UR. Similarly, mean values of cast number were of the order PD > CB > BS > CD = PM > SD > UR > CT, while mean values of cast weight were of the order PD > CB > BS > PM > CD > SD > UR > CT. The results of this study showed that organic sources of nitrogen provided a good suits tract for earthworm activities far above the inorganic nitrogen source and the control. As indicated in Table 3 there was significant differences (p = 0.05) in some chemical properties of earthworm cast produced under the different nitrogen sources. Soil pH in 1:1 soil-water suspension did not show any significant difference indicating that pH of the casts ranged from moderately acid to very strong acid (USDA – NRDS, 1998). Soil organic carbon, total nitrogen and C: N ratio indicated significant differences in their soil properties among the different nitrogen sources. SOC highest under SD and lowest under CT, highest Total nitrogen was recorded under UR and lowest under CT. The highest C: N ratio was recorded under SD treatment while the lowest was recorded under UR treatment. Among the organic nitrogen sources, there were no significant differences in C: N ratio between PD, CD, BS, PM and CB treatments. The C: N ratio of the CT was significantly higher than the values obtained for all the nitrogen sources, while the C: N ratio for UR was significantly lower than those obtained for the organic nitrogen sources. Data on available phosphorous indicate that the highest value was measured under PD, while the lowest value was measured under SD. All the nitrogen sources had higher available phosphorous content than the SD and CT treatment. Exchangeable Ca was significantly high under SD, PD, CD, BS, PM and CB when compared with CT and UR. There was no significant differences in exchangeable Ca between SD, PD, CD, BS, PM and CB, as well as between CT and UR. Highest value of exchangeable Mg was measured under CD, while the lowest value was measured under CT. For exchangeable K, highest value was measured under PD, while the lowest value was measured under CT. For exchangeable Na, highest value was measured under CD, while lowest value was measured under CT. Exchangeable acidity and ECEC were highest under CD and lowest under CT. there was no significant differences in base saturation among the different nitrogen sources. Values for all base saturation were all high (>90.0%) for all the nitrogen sources. Data on chemical properties of worm casts reported in this study confirm those previous researchers (Okoro, 2010), who reported that properties of worm cast are affected by soil management practices such as organic manure and inorganic fertilizer application. Data presented in Table 4 indicate that worm cast had higher pH value than the corresponding soil. The observation confirms reports by Okoro, 2010. According to Lee (1985), the higher pH in cast could be as a result of the actions of calciferous glands in the worm pharynx when soil is ingested. Higher pH values in casts maybe beneficial particularly in the acid soils (with acid Ultisols in south-eastern Nigeria) where low pH can inhibit nitrification. Data in Table 3 also showed that earthworm casts were characterized by higher SOC, total N, available P, ECEC and exchangeable Ca, Mg, K and Na than the surrounding soil but similar exchangeable acidity and base saturation with the surrounding soil. Jouquet*et al.,* (2008) also reported that worm casts had higher SOC, total N, available P, ECEC and exchangeable Ca, Mg and K contents than the surrounding soils. The results of this study seem to indicate that the addition of nitrogen containing materials will increase earthworm population and activities in the soil.

Table 2: Some chemical properties of the nitrogen sources used in the study

Nitrogen Source	Earthworm population (No/m^2)	Earthworm biomass (g/m^2)	Earthworm cast number (No/m^2)	Earthworm cast weight (g/m^2)
(CT)	2.8	0.17	8.0	21.89
(UR)	2.3	0.14	8.2	24.78
(SD)	3.6	0.21	8.7	25.37
(PD)	4.9	0.68	13.3	49.05
(CD)	3.1	0.25	9.1	25.64
(BS)	2.7	0.31	9.3	28.33
(PM)	3.1	0.37	9.1	27.89
(CB)	2.9	0.31	10.1	28.89
Mean	3.2	0.30	9.5	28.98
LSD(0.5)	1.3	0.09	1.0	9.97

Table 3: Mean chemical properties of earthworm casts sampled after cowpea harvest in 2009 and 2010 as influenced by nitrogen sources

Nitrogen sources	**pH (1:1 H20)**	Organic C (%)	Total N (%)	C.N	Avail. P (mgkg^{-1})	Exch. cations Ca	Mg	K	Na	Exch. Acidity	ECEC	Base sat. (%)
CT	5.0	1.16	0.12	9.7	42.3	8.9	3.3	0.21	0.30	1.22	13.93	91.2
UR	5.2	1.19	0.25	4.8	47.0	8.7	3.5	0.22	0.34	1.30	14.06	90.8
SD	5.3	1.54	0.14	11.0	38.5	11.4	3.4	0.23	0.33	1.37	16.73	91.8
PD	5.4	1.30	0.20	6.5	50.7	11.4	3.4	0.32	0.36	1.41	16.89	91.7
CD	5.3	1.31	0.18	7.3	40.7	11.5	4.2	0.30	0.40	1.42	17.82	92.0
BS	5.6	1.21	0.16	7.6	43.3	10.7	3.8	0.26	0.36	1.40	16.52	91.5
PM	5.4	1.32	0.18	7.3	46.6	10.1	3.9	0.28	0.37	1.37	16.02	91.4
CB	5.4	1.33	0.20	6.7	45.4	11.5	4.0	0.31	0.36	1.36	17.53	92.2
Mean	5.3	1.46	0.18	7.6	44.3	10.5	3.7	0.27	0.35	1.36	16.19	91.6
LSD (%0.05)	0.6	0.12	0.05	1.5	2.1	1.2	0.3	0.03	0.04	0.12	1.85	1.6

Table 4: Mean soil chemical properties of 0 – 30 cm depth sampled after cowpea harvest in 2009 and 2010 as influenced by nitrogen sources

Nitrogen Source	pH(1:1H$_2$0**)**	Organic C (%)	Total N (%)	C.N	Avail. P (mgkg^{-1})	Exchangeable cations				Exch. Acidity	ECEC	Base sat.
			CaMg	K	Na							
Control (CT)	4.5	1.05	0.12	8.8	19.5	3.0	1.9	0.09	0.07	1.16	6.22	18.4
Urea (UR)	4.7	1.10	0.21	5.2	21.3	3.3	2.3	0.12	0.09	1.21	7.02	87.8
Sawdust (SD)	4.9	1.14	0.12	11.8	20.6	3.5	2.1	0.12	0.09	1.29	7.13	81.5
Poultry dropping (PD)	5.1	1.21	0.17	7.1	21.9	3.4	2.5	0.11	0.10	1.32	7.44	82.1
Cow dung (CD)	5.2	1.25	0.16	7.8	25.1	3.5	2.4	0.10	0.11	1.33	7.44	82.1
Brewers' spent grains(BS)	5.5	1.16	0.19	6.1	23.8	3.5	2.3	0.13	0.12	1.31	7.36	82.2
Pig manure (PM)	5.3	1.13	0.16	7.1	22.4	3.4.	2.2	0.12	0.12	1.30	7.14	81.8
Combination (CB)	5.2	1.24	0.15	8.3	21.8	3.3	2.2	0.11	0.11	1.30	7.02	81.5
Mean	5.1	1.19	0.16	7.8	22.1	3.4	2.3	0.11	0.11	1.28	7.01	81.9
LSD (0.05)	0.4	0.11	0.04	1.3	2.1	0.2	0.2	0.01	0.02	0.13	0.32	1.5

Conclusion

The results of the study indicated that the addition of nitrogen containing materials will increase earthworm population and activities in the soil. Earthworm population and activities were all significantly higher ($p = 0.05$) for the poultry dropping treatment when compared with the other treatments and lowest for the urea treatment and control treatment.

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Effect of Crude Oil Pollution Levels and Plant Species on Soil Properties in the Niger Delta Region of Nigeria

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Abstract
A study was conducted at the screen house of the Teaching and Research Farm of Akwa Ibom State University, to evaluate the effects of crude oil pollution levels and plant species on soil properties. Twelve varieties of plant species (Axonopus compressus, Pennisetum purpureum, Eleusine indica, Panicum maximum, Leuceana leucocephala, Gliricidia sepium, Talinum fructicosum, Chromoleana odorota, Cyperus rotundus, Calapogonium mucunoides, Jatropha curcas,Centrosema pubescens) and a control with four levels of crude oil (0, 2.5, 5.0 and 7.5 % (w/w)) were fitted into a Completely Randomized Design with three replications. Significant differences were observed among crude oil pollution levels and different plant species used on the soil chemical properties while there was no significant effect on the texture of the soil. At 2 and 4 months after crude oil pollution, increase in crude oil pollution level significantly (P < 0.05) decreased the soil pH, available P, exchangeable bases and ECEC while organic carbon, total nitrogen and base saturation were significantly increased relative to the control.
Keywords: Crude oil, plant species, pollution, soil properties and Niger Delta

Introduction
Contamination of soils with petroleum hydrocarbon and their subsequent degradation has become a major concern because of the critical role of soil resources in promoting sustainable environment and economic development. Both inorganic and organic compounds in soils may not only adversely affect their production potentials but may also compromise the quality of the food chain and the underlying ground water. The survival of any human being depends on the quality of the soil. Soil supports terrestrial life through detoxification of pollutants, biomass production, restoration and resilience of ecosystems and cycling of some nutrients like carbon, boron, phosphorus, sulphur and water (Lal, 2001). Soil quality is depleted as the soil is contaminated through individual or combined processes such as crude petroleum oil pollution. When a soil is polluted, its capacity to produce is reduced.Oil pollution is of a great concern the world over; contamination of the environment by crude oil is a global problem in that it leads to loss of vegetation, food insecurity and biodiversity. Considering the detrimental effects of crude oil pollution on soil and plants and its attendant implications on food security and environmental integrity, this study was designed to evaluate the effects of various levels of crude oil pollution grown with different plant species on soil physicochemical properties of the Niger Delta Region of Nigeria.

Materials and Methods
Experimental site: The experiment was conducted at the screen house of the Teaching and Research Farm ofFaculty of Agriculture, Akwa Ibom State University, Obio Akpa Campus in Oruk Anam Local Government Area. Obio Akpa is situated between latitude $4^{o}30^{1}$ and $5^{o}30^{1}$N and longitude 7^{o} 31^{1} and $8^{o}0^{1}$E (SLUK, 1989). The total rainfall ranges from 2000- 2500 mm annually

while the mean temperature ranges from 24 -30^{o}C. The mean relative humidity ranges between 75- 79%.

Experimental materials/sources and preparation: Plastic buckets (5litres capacity) were perforated at the bottom to allow for easy drainage and facilitate aeration.Top soil (0-30 cm) used for the experiment was taken from the Teaching and Research Farm of the Faculty of Agriculture, Akwa Ibom State University, ObioAkpa Campus using a spade. Crude oil was obtained from Shell Petroleum Development Company (SPDC) Limited, Port Harcourt, Rivers State, Nigeria.

Treatments, experimental design, application and planting: Twelve varieties of plant species *(Axonopus compressus*, *Pennisetum purpureum*, *Eleusine indica*, *Panicum maximum,Leuceana leucocephala*, *Gliricidia sepium*, *Talinum fructicosum*, *Chromoleana odorota*, *Cyperus rotundus*, *Calapogonium mucunoides*, *Jatropha curcas,Centrosema pubescens)* and a control (no plant) were grown in soils polluted with four levels of crude oil (0, 2.5, 5.0 and 7.5 % (w/w)). The experimental design used was a Completely Randomized Design with three replications.

To each of the perforated plastic bucket containing 5 kg of soil, the various levels (0%, 2.5% , 5%, 7.5%)of crude oil pollution were thoroughly mixed with the soil and watered to field capacity for a period of seven days before planting the species. The duration of the pot experiment was four months.

Soil sampling/processing and laboratory studies: One composite soil sample was taken before experiment and soil in each pot was sampled at 2 and 4 months after pollution for laboratory analysis. The soil samples were air dried, ground and sieved with 2 mm size sieve and physicochemical properties analyzed following standard procedures as outlined by Udo *et al*. (2009). The properties analyzed include particle size distribution, soil pH (H_2O), organic carbon, total nitrogen, available phosphorus, exchangeable bases and exchangeable acidity. Effective cation exchange capacity and base saturation were calculated.

Sample of the crude oil used for the study was also subjected to chemical analysis using standard procedures.

Results and Discussion

Properties of the soil and crude oil used for the study: The result of the physico-chemical properties of the soil before crude oil application is shown on Table 1. Particle size distribution was dominated by sand with texture being loamy sand. Soil pH was slightly acidic (6.1) organic matter and available phosphorous were high while total nitrogen was low as classified by Chude *et al*. (2012). Results of the analysis of crude oil are also presented in Table 1.

Effects of crude oil pollution levels on soil properties at 2 and 4 months after pollution

The effects of crude oil pollution levels on some physicochemical properties of the experimental soil at 2 and 4 months after pollution are shown on Table 2.At 2 and 4 months after pollution (MAP), successive increase in the concentration of crude oil had no significant ($P > 0.05$) effect on soil texture. Similar result was obtained by Marines cu *et al*. (2001) and Abosede *et al*. (2013), who reported that pollution of the soil with crude oil, had no significant influence on textural classes of the soil when compared with the control. At 2 and 4 MAP, there was significant reduction ($P<0.05$) in the soil pH level among the different pollution levels when compared with the control (Table 2). The pH value was highest in the control pot where there was no pollution and was least in the 7.5 % (w/w). It was observed that, pH decreased with increased in the concentration of crude oil. This is in line with the observation of Ijah *et al*. (2008) who observed decrease in pH value in crude oil polluted soils. This acidity may be associated with the acidic nature of the oil or may also be attributed to the leaching of basic cations in soil solution which is typical of soils of the south eastern part of Nigeria. At 2 and 4 MAP, percent organic carbon and total nitrogen contents were higher at 7.5 % (w/w) pollution level and least in the control (Table 2). Ijah *et al*. (2008); Eneje *and Abomotei* (2011) and Ogboghod *et al*. (2004) also reported increases in percent organic carbon content in the soil with crude oil pollution and attributed this to microbial mineralization of crude oil in the soil. Higher concentration of soil total nitrogen with higher pollution level of crude oil in this study agrees with the report of Udo (2008), who reported increases in percent total nitrogen in polluted soils. This observation suggest that the crude oil could contain nutrients (nitrogen) or initiate soil reactions that favour the availability of soil nutrients in polluted soils. The available phosphorus differed significantly ($P<0.05$) among the different pollution levels (Table 2). This result confirmed existing studies by (Ogboghodo *et al*.(2004), Isirimah *et al*. (1989) and Eneje and

Ebomotei (2011) who observed decreases in availablephosphorus with increases in crude oil pollution level. At 2 MAP, the control pots recorded the highest content of exchangeable bases and acidity. However, at 4 MAP, the control was not significantly different in exchangeable bases from the oil impacted soils. The reduction in Ca, Mg, K and Na may be due to nutrient immobilization or complexation in the soil after uptake by plant. Base saturation values were not significantly different ($P>0.05$) among the different pollution levels and the control at 2 MAP. At 4 MAP, values were much higher in the polluted soils than the unpolluted soil (Table 2).

Effects of different plant species grown on crude oil polluted soils on some chemical properties of the soil

The results of the effects of different plant species grown on crude oil polluted soils on some chemical properties of the soil are presented in Table 3. Soil planted with *Pennisetum purpurem* (V_2) had the highest pH value while soil planted with *Centrosema pubescens* (V_{12}) had the highest total N content. Significant ($P\leq0.05$) differences were observed in organic carbon, available phosphorus, exchangeable bases and exchangeable acidity. The result shows that, the different plant species decreased the exchange acidity of the soil. At 2 MAP, there was no significant ($P\leq0.05$) different in base saturation among soils planted with the different plant species when compared with the control (Table 3) but at 4 MAP soils planted with *Eleusine indica* (V_3) and *Pennisetum purpureum* (V_2) had the highest content of base saturation.

Conclusion

Different plant species grown in crude oil polluted soils impact on soil properties differently. Successive increases in crude oil pollution significantly ($P < 0.05$) decreased the soil pH, available P, exchangeable bases and ECEC while organic carbon, total nitrogen and base saturation were significantly increased relative to the control.

Table 1: Physicochemical properties of soil before experiment and characteristics of the crude oil used

Soil property		Characteristics of crude oil	
Parameter	**Value**	**Parameter**	**Value**
Sand (%)	88.60	Specific gravity (g/cm^3)	0.834
Silt (%)	4.50	Viscosity(CP)	0.28
Clay (%)	6.90	Carbon (%)	85.5
Textural class	loamy sand	Hydrogen (%)	12.61
Bulk density (g/cm)	1078	Sulphur (%)	1.48
Total porosity (%)	32.5	Nitrogen (%)	0.47
pH (H_2O)	6.1	Oxygen (%)	0.50
Organic carbon (%)	0.29	Trace metals (%)	0.13
Total nitrogen (%)	0.97	Gas: oil ratio	88.1
Available P (mg/kg)	41.29		
Exch. Ca (cmol/kg)	6.40		
Exch. Mg (cmol/kg)	3.28		
Exch. Na (cmol/kg)	0.06		
Exch. K (cmol/kg)	0.12		
TEB (cmol/kg)	9.86		
Exch. acidity(cmol/kg)	2.72		
ECEC (cmol/kg)	12.58		
Base saturation (%)	78.38		

Table 2: Effects of different concentrations of crude oil on some physicochemical properties of the experimental soil at 2 and 4 months after pollution in the screen house

Treatments	Sand (%)	Silt (%)	Clay (%)	Texture	Soil pH	Org. C. (%)	Total N (%)	Avail. P mg/kg	Exchangeable cations cmol/kg				Exchange acidity		ECEC cmol/kg	Base Sat. (%)
									Ca	Mg	K	Na	Al	H		
2 months after pollution																
0 (Control)	88.33a	5.07a	6.60a	LS	5.13a	1.30d	0.11d	31.35a	5.35a	1.25a	0.10a	0.07a	0.17a	0.98a	7.76a	83.16a
2.5	88.00a	5.70a	6.30a	LS	5.04b	2.28c	0.19c	23.64b	5.07b	1.22a	0.09b	0.07a	0.05d	0.85b	7.12b	84.85a
5.0	79.69a	5.70a	6.83a	LS	4.97c	2.71b	0.23b	18.88c	4.39c	1.15ab	0.09b	0.06b	0.08b	0.81b	6.65c	83.21a
7.5	86.51a	3.89a	9.60a	LS	4.96c	4.01a	0.29a	15.38d	4.31c	1.12b	0.08c	0.07a	0.06c	0.74c	6.86b	81.40a
					4 months after pollution											
0 (Control)	85.95a	3.50a	10.55a	LS	5.23a	0.62d	0.06b	41.70a	3.67a	2.06a	0.12a	0.14a	0.01a	0.54a	6.44a	91.12b
2.5	86.50a	3.90a	9.60a	LS	5.10b	0.92c	0.07b	38.65b	2.92b	1.78b	0.12a	0.08b	0.01a	0.36c	4.94c	91.67a
5.0	85.40a	4.90a	9.62a	LS	5.01c	1.19b	0.12a	33.46c	2.63c	1.82b	0.12a	0.07b	0.01a	0.37b	5.29b	92.05a
7.5	85.90a	4.55a	9.55a	LS	4.97d	1.39a	0.12a	23.69d	2.57c	1.53c	0.10a	0.08b	0.01a	0.34d	4.71d	91.87a

Means in the same column followed by same letter (s) are not significantly different at 5% probability level
Org. C = Organic carbon, T/N = Total nitrogen, Avail. P = Available phosphorus, Exchangeable magnesium, Exch. Na. = Exchangeable sodium, Exch. K = Exchangeable potassium, ECEC = Effective cation exchange capacity, EA = Exchangeable acidity, Base Sat. = Base saturation.

Table 3: Effects of different plant species grown on crude oil polluted soils on some physicochemical properties of the experimental soil at 2 and 4 months after pollution in the screen house

Plant species	Soil pH (H_2O)	Org. C. (%)	Total N (%)	Avail. P (mg/kg)	Exchangeable cations				Exchange acidity		Base Sat. (%)	ECEC (cmol/kg)
					Ca	Mg	K	Na	Al	H		
					← cmol/kg →							
2 months after pollution												
V_o	4.450g	3.005c	0.2150e	21.90e	5.233bc	1.550a	0.1075a	0.0775a	0.0475f	0.7925cd	88.75a	7.800a
V_1	4.975d	2.455h	0.1925f	25,43c	4.233g	1.008cd	0.0850gh	0.0666d	0.1200b	0.9558b	83.08a	6.448e
V_2	5.050cd	2.670f	0.2225de	27.78b	5.000de	1.600a	0.0825h	0.0666d	0.0933de	0.7383f	83.41a	7.258c
V_3	5.250a	2.140k	0.1675ghi	19.54g	3.725h	1.033c	0.0900fg	0.0683cd	0.1058bcd	0.9900a	81.77a	6.118f
V_4	4.833e	2.180j	0.1575i	22.02e	3.842h	1.042c	0.0908ef	0.0675d	0.09991cde	1.0100a	80.73a	6.078f
V_5	5.000d	1.913i	0.1692ghi	33.70a	5.200bcd	1.050c	0.0983bed	0.0750ab	0.1608a	0.8075c	83.33a	7.508b
V_6	4.650f	2.435i	0.1850f	21.05f	5.27b	1.575a	0.0941def	0.0733abc	0.0500f	0.7975cd	83.86a	7.639ab
V_7	5.225a	2.540g	0.1950f	15.85i	5.033cde	1.542a	0.0891fg	0.0758ab	0.0475f	0.7983cd	76.98a	7.608ab
V_8	5.075bcd	2.735e	0.2325cd	15.94i	4.500f	0.825d	0.0908ef	0.0675d	0.1566a	0.7592cf	84.00a	6.504e
V_9	5.150abc	2.148k	0.1515hi	19.69g	4.35fg	1.033c	0.1008bc	0.0716bcd	0.0850e	0.9917a	82.72a	6.841d
V_{10}	5.250a	3.088b	0.2617b	25,75c	5.658a	0.900cd	0.1000bc	0.0766ab	0.0483f	0.7767de	84.83a	6.778d
V_{11}	5.250a	2.977d	0.2358c	18.44h	4.817e	0.992cd	0.0958cde	0.0775a	0.1100bc	0.7808cde	86.13a	7.493b
V_{12}	5.175ab	3.203a	0.2775a	22.97d	5.267b	1.258b	0.1016b	0.0683cd	0.0466f	0.7867cde	81.43a	7.700ab
4 months after pollution												
V_o	4.958e	1.026d	0.0925a	34.58bcd	2.600c	1.075d	0.1600a	0.2550a	0.0125a	0.4550a	89.22g	4.220f
V_1	5.317b	1.012de	0.1042a	40.96a	2.950bc	2.175ab	0.1800a	0.0775b	0.0125a	0.3822d	92.47bc	5.730c
V_2	5.550a	1.315a	0.1075a	40.00a	3.300ab	2.325a	0.1100a	0.0825b	0.0125a	0.3723d	93.50a	6.220a
V_3	5.083d	0.830h	0,0875a	36.93b	2.933bc	2.150ab	0.1700a	0.0775b	0.0100a	0.3724d	93.55a	5.650c
V_4	5.017de	0.797i	0.0825a	35.93bc	3.000bc	2.150ab	0.1000a	0.0775b	0.0100a	0.3723d	93.07ab	5.730c
V_5	5.317b	0.980fg	0.0800a	28,84fg	3.600a	1.775bc	0.1100a	0.0825b	0.0100a	0.4311b	92.75abc	6.000ab
V_6	5.092d	1.130e	0.0925a	34.68bcd	2.700c	1.133d	0.0999a	0.0750b	0.0125a	0.4550a	89.75fg	4.380f
V_7	5.100d	0.997ef	0.1475a	28.07g	2.700c	1.425cd	0.1100a	0.0725b	0.0150a	0.4100c	90.42ef	4.751e
V_8	5.242bc	0.965g	0.0850a	28.79fg	3.533a	1.725c	0.1100a	0.0775b	0.0075a	0.4100c	92.12cd	5.862bc
V_9	5.133cd	0.782i	0.0775a	33.97cd	2.725c	2.125ab	0.0999a	0.0750b	0.0125a	0.3724d	93.00ab	5.402d
V_{10}	5.267b	1.317a	0.1050a	31.24ef	2.750c	2.275a	0.1000a	0.0825b	0.0125a	0.3811d	90.72e	5.733c
V_{11}	5.225bc	1.005e	0.0850a	32.22de	2.975bc	1.713c	0.1000a	0.0800b	0.0100a	0.4311b	91.50d	5.365d
V_{12}	5.275b	1.51b	0.0967a	40.65a	2.550c	1.300d	0.0999a	0.0725b	0.0150a	0.4451ab	89.72fg	4.451f

Means in the same column followed by same letter (s) are not significantly different at 5% probability level.

V_o=No plant, V_1=Carpet grass (*Axonopus compressus*), *V_2*=Elephant grass (*Pennisetum purpureum*), *V_3*=Goose weed (*Eleusine indica*), *V_4*=Guinea grass (*Panicum maximum*), *V_5*=White leadtree(*Leuceana leucocephala*), *V_6*=Gliricidia (*Gliricidia sepium*), *V_7*=Waterleaf (*Talinum fructicosum*), *V_8*=Siam weed (*Chromoleana odorata*), *V_9*=Nut Sedge weed (*Cyperus rotundus*), *V_{10}*=Calapo (*Calapogonium mucunoides*), *V_{11}*=Jatropha (*Jatropha curcas*), *V_{12}*=Centro (*Centrosema pubescens*).

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An Assessment of Farmers Use of Soil Survey Information in Crop Production and Local Classification of Soils, Niger State, Nigeria

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Abstract
The study assessed farmer's use of soil survey information in crop production and local classification of soils, Niger state. Nigeria. Multi stage sampling technique was used to select 120 respondents within the three agricultural zones of the state for the study. Data for the study were collected using a structured questionnaire. Descriptive statistics was used to analyse the data. The result revealed 99.2 % of the respondents know about soil information with 64.2 % introduced to soil information by extension agents. Majority of the respondents were not aware of the importance and use of soil information, with the mean level of awareness of farmers towards soil was low with average of 1.78. Majority of the respondents agreed with the notion that soil information can increase productivity and lead to sustainable agriculture, with the mean level of agreement revealed to be high with an average of 3.64. The respondents disagreed with the notion that soil information is needed for only large-scale farming. The study also revealed that 66.7 % of the respondents locally classify their soils in the study area, using topsoil physical characteristics such as soil colour, soil weight and feel as indicators for classification. The respondents were not aware of the importance of soil information, but are willing to adopt the use of soil information, if more awareness programs and reduced cost of soil analysis are in place. The respondents classify soils locally but their classification lacks depth, with need for in-cooperation of scientific classification, which can lead to a more accurate local classification of the soil.
Keywords: Soil survey information and Local classification

Introduction
Soil plays a major role in the quality of our environment. It is the foundation for food and fibre production. Knowledge of soil is required for land use planning activities and the decision of what use a particular soil type could be assigned. Moreover, understanding of soil properties and processes is important in evaluating the criteria for soil management and cultivation and agricultural production. Esu (2004), Lobry de Bruyn and Andrew (2016) noted that increase in demand and lack of information on soils contribute to the problem if soil degradation and world food crises, due to the wrong use and poor management of land resources. Achukwu *et al*. (2013), Sharu *et al*. (2013) stated that for sustainable land management, information on the soil resources and how to manage them is needed and this is achieved through characterization, classification and evaluation of the soil. Lobry de Bruyn and Abbey (2003), Lobry de Bruyn and Andrews (2016) all noted that there a lot of barriers to collecting and acting on soil information, with majority of farmers soil-information poor, or at least they are not informed as to the condition of their soil by soil testing. A challenge to agricultural production is that farmers, in particular small-scale farmers, do not know the status of their soils. The ability to have data that can move across states and borders are vital for the agricultural sector in today's global market environment (FAO, 2017), the only way agricultural production can be sustained is when farmers can assess adequate and accurate data. In Nigeria there is a lack of collection and management of agricultural data and inadequate data in agriculture will hinder foreign direct investment and governments efforts to reform the agricultural sector, since quality data improves both sectoral benefits and real economic benefits (Essiet, 2015). In Nigeria, like most developing countries, one primary

constraint to sustainable and successful agricultural program, is lack of knowledge about the soil resources and how to manage them (Achukwu *et al.,* 2013). Boonsompopphan *et al*. (2008) noted that with the ability of farmers to identify soil series farmers could obtain site-specific nutrient recommendations and as a result of applying site-specific nutrient management. In Niger, there have been wide spread survey of the soil, documenting the fertility status in conjunction with management practices which can improve the soil fertility and reduce soil degradation. However, these recommendations have majorly not been adopted by farmers, with the reason for this basically being the lack of knowledge and information by the farmers. Also, there has been lack of knowledge of the perception of farmers towards soil data and their willingness to use the data presented to them, which might have led to bridging the gap between researchers and farmers. Since, there have been few studies in Minna, that document farmers view on soil data and their utilization. The study was therefore designed to identify how soils are classified, assess the level of awareness, perception and use of soil information by farmers in crop production in Niger State, Nigeria.

Methodology

The study was carried out in the three agricultural zones of Niger State, Nigeria. It lies between longitude 6^0 25′ E and $6^0$45′ E and Latitude $9^0$24′ N and $9^0$48′ N and is at an elevation of 299 m above sea level. Niger falls under the Southern Guinea Savanna agro-ecological zone of Nigeria, the climate of Minna is sub-humid with mean annual rainfall of 1284 mm and a distinct dry season of about 5 months duration occurring from November to March (Ojanuga, 2006). The mean maximum temperature remains high throughout, about 33.5^0 C, particularly in March and June (Ojanuga, 2006). The soils of the study area are grouped under the Southern belt of forest soils which have underlying rocks of granite or clay, with soils rich in clay loam, and zone of alluvial soils which are fresh - water soil of grey to white sand, grey clay and sandy clay with humic topsoil (Iloeje, 2001). The soils are generally low in organic matter, total nitrogen and available phosphorus with high erodibility, are structurally weak, coarse textured with low organic matter status (Ahmakhian and Osemwota, 2012). A multi-stage sampling technique was used to select the respondents for the study. Stage one involved random selection of one (1) Local Government Area from each agricultural zone, stage two (2) was random selection of two (2) villages from each Local Government Area. Stage three (3) was random selection of twenty (20) rural farmers from each village to give 120 respondents for the study. Primary data was collected with the use of structured questionnaire, complimented with an interview schedule. Data collected was analysed using descriptive statistics such as mean, standard deviation, pie chart, bar chart, percentages and frequency distribution as appropriate. Attitudinal measuring scale like likert rating scale was also used to categorize the respondent responses into 3-point and 5-point likert rating scale.

Results and Discussion

Institutional characteristics

Table 1 shows that majority of the respondents (52.5 %) are permanently practising agriculture with 28.3 % utilizing trading as a secondary occupation. The table also shows that (99.2 %) of the farmers have contact with agricultural extension agents, with frequency of the contact majorly bi-weekly (42.5 %), which may lead to higher rate of adoption of information and new technologies. This is accordance with Shehu *et al*. (2016) who noted that farmers who had more contact with extension agents are more than two times likely to adopt modern technology than those with no access to extension agents.

Table 1: Some institutional characteristics of respondents

Variables	Frequency	Percentage
Secondary occupation		
Farming	63	52.5
Trading	34	28.3
Civil servant	2	1.7
Processing	21	17.5
Cooperative Membership		
Yes	88	73.3
No	32	26.7
Access to credit		
Yes	56	46.7
No	64	53.3
Source of Credit		
None	58	48.3
Agricultural bank	62	51.7
Extension Contact		
Yes	119	99.2
No	1	0.8
Frequency of Contact		
Weekly	28	23.3
Bi-weekly	51	42.5
Monthly	41	34.2

Source: Field survey, 2018

Distribution of respondents on knowledge about soil information

Majority (99.2 %) of the respondents know about soil information. This may be due introduction by extension agents, since the framers have a high level of contact with extension agents. Majority of the respondents (64.2 %) were introduced to soil information by extension agents and 57.5 % of the respondents use form soil information, while carrying out farming activities.

Local classification of soil

Table 3 shows respondents from different localities possess varying local classification of soils, which were based on colour, weight and feel of the soil, which are observable top soil characteristics. This is similar to the findings of Nethononda and Odhiambo (2011) who observed that farmers classified soils based on top soil characteristics not taking into consideration of subsoil characteristics. This may be due to the farmers believe that most crops they cultivate majorly occupy the topsoil. Kuyi village farmers classified soils based on colour (red and white soil). The red soils are regarded as light clay soils and white soils regarded as loamy dark soils, with both type of soils used for both yam and maize farming. Taxakpan village farmers classified their soils locally based on weight (light and heavy soil). Where the light soils are regarded as loamy soils used for Maize, Ground nut, Cowpea and Yam farming, while Heavy soils are regarded as clay soils used for majorly rice farming. Sabon Rijiya and Kakapanji village farmers classified their soils based on its feel. Sabon Rijiya respondents classified their soils as smooth and rough soil, with smooth soils regarded as clay soils used for majorly rice farming while rough soils are regarded as sandy to loamy soils used for maize and ground nut framing. Kakapanji village respondents classified their soils used smooth and stony soil, with smooth soils regarded as clayey soils used for rice farming while stony soils are regarded as sandy to loamy soils coarse feel used for Maize, yam and Ground nut farming. The table shows that 66.7 % of respondents within the study area classify their soils locally, which aid them in selecting crops that they cultivate, which in turn increase land sustainability. This is in collaboration with findings with of Nethononda and Odhiamo (2011) who stated farmers local classification is important for sustainable agricultural development planning and land suitability evaluation in developing countries where financial resources are scarce.

Table 3: Local classification of soils by respondents

Classification	Frequency	Percentage
KUYI VILLAGE		
Red soil	20	100
White soil	20	100
TAXAKPAN VILLAGE		
Light soil	20	100
Heavy soil	20	100
SABON RIJIYA		
Smooth soil	20	100
Rough soil	20	100
KAKAPANJI		
Smooth soil	20	100
Stony soil	20	100
Total	80	66.7

Source: Field survey, 2018

Awareness if respondents about soil information

Table 4 shows the awareness of farmers about soil information in the study area. Awareness about soil information (1.98), awareness on use of soil information (1.93) and awareness that soil information improves yield (1.79) were the statements the farmers were most aware about. All the mean scores were than 2.00 indicating they are generally not aware of all the statements on table 4. This may imply that most farmers do not use standard soil information for farming. Okunola (2009) stated that awareness is the first stage of adoption before respondents develop interest in the technology and later decide on adoption.

Table 4: Awareness of respondents about soil information

Statements	HA	A	NA	WS	WM	Decision
Awareness about soil information	0	118	2	238	1.98	Not aware
Awareness of use of soil information	0	112	8	232	1.93	Not aware
Awareness on importance of soil information	9	49	62	187	1.56	Not aware
Awareness that soil information improve yield	23	49	48	215	1.79	Not aware
Awareness that soil information improves fertility	13	61	46	207	1.73	Not aware
Awareness that soil information reduces cost of production	11	66	43	208	1.73	Not aware
Awareness that soil information reduces soil deterioration	14	61	45	209	1.74	Not aware

HA = Highly aware, A = Aware, NA = Not aware, WS = Weighted sum, WM =Weighted mean

Farmers' perception about soil information

Table 5 shows the perception of farmers towards soil information. Improvement of yield (3.98), improvement of soil fertility (4.20), encouragement to farm (3.86), lack of knowledge on soil information (3.83) and high cost of soil analysis (3.71) were the statements the respondents majorly agreed upon with the mean scores above 3.00. This means that if farmers are educated about soil information, they are able to understand, utilize and transfer soil information to other farmers. This is similar to the findings of Duruiheoma *et al.* (2015) who stated that highly aware farmers aid in transferring knowledge between older farmers and farm owners, through a possible knowledge transfer network, where knowledge about soils are shared.The farmers majorly disagreed with the perception that soil information is only necessary for large scale farming (2.14), which may mean farmers are willing to adopt use of soil information in their farming activities if made available to them, with reduced cost of soil analysis being the incentive they require.

Table 5: Perception of respondents about soil information

Statement	SA	A	UD	D	SD	WS	WM	Decision
Soil information improves yield	0	118	2	0	0	478	3.98	Agree
Soil information improves soil fertility	27	90	3	0	0	504	4.20	Agree
Soil information is necessary for agricultural production	22	51	43	4	0	451	3.76	Agree
Soil information encourages people to farm	30	45	43	2	0	463	3.86	Agree
Soil information reduces soil deterioration	16	35	68	1	0	426	3.55	Agree
Soil information is only necessary for large scale farming	0	0	18	101	1	257	2.14	Disagree
Soil information reduces stress	1	72	47	0	0	434	3.62	Agree
Soil information is too expensive	0	85	35	0	0	445	3.71	Agree
There is lack of knowledge on soil information	4	93	22	1	0	460	3.83	Agree
Inadequate information on soil information	5	76	38	1	0	445	3.71	Agree

SA = Strongly agree, A = Agree, UD = Undecided, D = Disagree, SD = Strongly disagree

Conclusion

The result of this research showed that majority of the farmers have been introduced to soil information but not all use it for farming. Even though, they were introduced to soil information there is a gap in knowledge regarding the relevance and use of soil information, due to the fact that extension agents did not disseminate such information to the farmers. The farmers also agree with the notion that soil information can increase agricultural productivity and bring about sustainable agriculture, although this depends on the availability of soil information to them in terms of reduced cost of soil analysis and more awareness programs. The farmers identify fertile soils based observable characteristics majorly crop yield, soil colour and soil texture, this form of identification does not take into consideration of the fertility status of the subsoil. Most of the farmers classify their soils locally and this serves as a means of selecting specific crops to suit specific crop types, although there is a gap between scientific classification of soils and local classification with local classification only taking into consideration the colour and texture of the soil, linkage between farmers, extension agents and soil scientist can bridge the gap in classification allowing for farmers to in-cooperate more parameters into their form of classification.

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Water Resources Management in Nigeria: Challenges and Way Forward for Sustainable Agriculture

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Abstract
Water resources management in Nigeria is neither homogenous, nor constant or consistent overtime. They vary from one region to another, sometimes even within a single state, from one season to another, and also from one year to another. This paper is a review of water resources in Nigeria, challenges and way forward for sustainable agriculture. Climate variability, growing urban demand, unrestricted extraction, land use change and poor funding were identified as some of the challenges. Solutions to the challenges of water resources management depend not only on water availability, but also on many other factors, among which are the processes through which water is managed, competence and capacities of the institutions that manage them, prevailing socio-political conditions and expectations which affect water planning, development and management processes and practices, appropriateness and implementation status of the legal and regulatory frameworks.
Keywords: Water resources management, challenges, agriculture, and Nigeria

Introduction
Nigeria is endowed with abundant natural water resources evident in her substantial yearly rainfall, large surface bodies of water-rivers, streams and lakes, as well as in abundant reservoirs of underground water whose extent and distribution have not been fully assessed. With a population of 167 million (Oyebande, 2011), Nigeria is the most populous country in Africa, with a GDP second only to South Africa's. Yet, following several years of military rule and poor economic mismanagement, Nigeria experienced a prolong period of economic stagnation, rising poverty levels, and the decline of its public institutions in spite of her abundant human and natural resources. Water Resources Management is of direct interest to the society as a whole, as well as to most development related public institutions at central, state and municipal levels, academia, private sector and non-governmental organizations (NGOs) (Okeke and Uzoh 2009). Such widespread interest in water is not a unique situation, as many water professionals have often claimed: it is equally applicable to other important sectors like food, energy, the environment, health, communication or transportation (Akpor and Muchie, 2011). All these issues command high levels of social and political attention in all modern societies, although their relative importance may vary from one state to another, and also overtime. In an increasingly interrelated and complex world, many issues are of high interest for assuring good quality of life of the people (Velayutham, 1999).
Development had been conventionally based on the use of natural resources since the vast population is rural and agricultural production is the main occupation. However, if land is expected to continue to produce, this and other resource base must at least be maintained, rehabilitated and properly managed. Fortunately, however, government and some non-government agencies, for instance the Nigeria conservation society are getting involved in creating an awareness of the need to use judiciously and to preserve the Nigerian environment (UN Water Report, 2012). Although preservation and other measure so far taken are steps in the right direction, they do not appear to be adequate, particularly in ensuring a widespread knowledge, especially among farmers of the relationship between the use of the environmental resources and its effects on agricultural and

sustainable development, hence, this paper is a highlight on water resources management in Nigeria – challenges and way forward for sustainable agricultural production.

Challenges of Water Resources Management in Nigeria

According to Salami *et al.* (2013), the main challenges facing the development and management of water resources in Nigeria include:

a. *Climate variability:* Increasing evidence of variability in earth's climate has prompted concern and controversy. The need to cope with existing variability and to adapt and build resilience brings significant implications for water resources availability and reliability associated with the greater likelihood of extreme events. There is mounting evidence of trends in hydrological series. Many areas face a drying and warming climate and thus potentially less water availability. Notwithstanding, flood experience which sub-merged some communities in some states once more called to remind the need for adequate measures and exigency of a structured plan that would serve as comprehensive guide in water resources management in Nigeria.
b. *Growing urban demand:* Due to the pressure of rapid population growth as well as poor management, the available resources of water are being depleted at a faster rate and the situation seriously underlines the need for taking up integrated plans for water conservation and utilization for every agro-ecological area to meet the increasing demands of irrigation, water harvesting, human and livestock consumption, expanding industry, hydro-electric power generation, recreation, navigation and other uses. Demand for water has increased dramatically resulting from, inter alia, increased wealth and increased demand for food and energy generation.
c. *Lack of basic planning data:* A major constraint to water resources development and management in Nigeria is lack of basic planning data. The role of data collection has regrettably either been underplayed or ignored. "It is therefore always very difficult to assemble reliable and adequate technical and socio-economic data capable of assisting in the assessment, planning, design, construction and maintenance of various development projects". Many projects have therefore failed because of the unreliable and inadequate data on which analysis planning, development and management were based.
d. *Allocation of water resources:* The water in many supply systems has been allocated on the basis of past availability or existing demand and has not been kept in line with current or future availability; thus, many systems are over-allocated. Also, the situation of water supply in urban and rural area is far from adequate. In many states, a sizeable population is not served by pipe borne water. Most of the populations in this zone do not have access to portable pipe borne water; most families collect water from unsafe sources, such as rainfalls, ponds, streams and rivers for domestic use and most of these sources are contaminated, thus leading to death of thousands due to water borne diseases. Lack of equitable access to potable water and sanitation, particularly in rural areas leads to greater time and effort spent on water collection by vulnerable groups including women, the poor, the aged, and children.
e. *Unrestricted extractions:* In many areas, there are no management plans or restrictions on water extractions (for example, pumping from rivers and groundwater extractions). These have resulted in less water being available. The expansion of farm dams in some areas also reduces the supply of water entering river systems, the indiscriminate springing up of boreholes across the various communities, states of Nigeria and even the unruly attitude of people toward building in water-ways, require precautionary measures that would prevent future flooding.
f. *Land-use change:* Clear-felling, expanding plantations and the opening of new areas to agriculture, all have impacts on the water resource. Some event, such as bush fires, leads to a reduction in the available water and water-quality problems. Changes to land use, even within agricultural areas and industrial area, have implications on both water availability and water use.
g. *Funds:* The challenge confronting the water sector in the area lies in meeting the staggering financing and capital investment required to increase the management of water resources. Unsustainable funding schemes for the provision of water and sanitation infrastructure and services, and hence a concentration on delivery with limited attention to issues of sustainability. Insufficient financial resources to meet investment demand for infrastructural development, inadequate cost recovery to recover the full costs of water supply services.

Government would hide behind the excuse of lack of money, in water resource management; the real problem is how the money is being spent and the competence of persons in-charge of spending such funds.

h. *Unfinished Projects:* Checks revealed that abandoned and uncompleted projects abound in the Ministry of water resources and other water development and management agencies in Nigeria.
i. *Water resources maintenance:* Overuse of water resources, primarily for agriculture, and diffuse contamination of freshwater from urban regions and from agriculture are stressing the water resources in the terrestrial water cycle. As a consequence, the ecological functions of water bodies, soils and groundwater (e.g. filtration, natural decomposition of pollutants, buffer capacity) in the water cycle are hampered. Most of its infrastructures are rarely maintained, for example pipe bursts and pipes in filthy drains are commonly found in almost all the areas of the zone, this leads to poor management of water resources.
j. *Inadequate institutional capacity-building:* Insufficient institutional capacity and cooperation to operationalize the concepts of sustainable water resources management and also lack of policy to promote the conservation of water contributed to challenges of water resources development and management.
k. *Insufficient technology:* This is manifested in the transfer from innovators to practitioners, limited application of appropriate technologies, information and knowledge to support decision-making and implementation.
l. *Sectorial management:* Each sector (domestic use, agriculture, industry, environmental protection, etc.) has been managed separately, with limited coordination between them. This led to fragmented and uncoordinated development of water resources. Water is by nature a flowing resource, which crosses sector boundaries. Many uses of water have spill-over effects on other uses, and water development projects have unintended social and environmental consequences. This is especially true for river basins where upstream water and land practices impact directly the quantity and quality of water in downstream areas. As water becomes scarcer, it is becoming increasingly inefficient to manage water without recognizing the interdependencies between agencies, jurisdictions, sectors and geographical areas. Each agency has been made responsible for only a limited aspect of water resources development and management. In addition, agencies in each subsector have largely independent strategies and programmes for resource development and operations. This has often created confusion, resulting in uncoordinated efforts in administering regulatory policies and site-specific issues in water resources management. Conflicts of interest in the utilization of water and overlapping of development activities are becoming more and more apparent.
m. *Non-viable and Unplanned Schemes:* Schemes (e.g., water supply schemes) which do not have assured water in the source, or which do not have favourable cost benefit ratios, are sometimes taken up for implementation purely for political considerations. Sometimes, schemes are announced by politicians and even foundations stones are laid, but there has been no exploration or thinking about the scheme by competent authorities about its feasibility and relevant departmental (e.g., environmental) clearances. Due to political compulsions, officials are often forced to implement the scheme – leading to further problems or incompletion, and hence, to a wastage of valuable water resources.
n. *Undue political interference:* Several politicians harass officials for a cut of the funds allocated for development of large government projects (e.g. irrigation), and derail planned work and/or victimise government officials (e.g. with punitive transfers) if their demands are not accommodated.
o. *Long delay in implementing planned water resources projects:* A combination of a lack of sufficient fund allocation (despite a higher agreed budget) and political conflicts over water rights and allocations have caused a large number of sanctioned irrigation projects to proceed slowly and hence overshoot their estimated costs due to inflation. This has led not only to continued hardship to the expected beneficiaries (and the frustration due to unfulfilled expectations), but also to a lack of belief in governmental and political promises.
p. *Low quality constructions:* Institutionalized corruption (where contractors, for instance, pay bribes to get contracts) has led to poor quality construction as these contractors try to reduce the quality of construction (e.g. in using less than required cement in concrete or substandard materials) to make up their profit margins. This leads to dangerous construction, and collapsing water resources structures.

q. *Institutionalized Corruption:* While there are established systems (of percentages) of corruption in sanctioned projects, corrupt politicians and bureaucrats inflate costs of new proposals as well. Upright bureaucrats, who protest these systems or take strict action against corrupt officials or politicians, are victimized – often with allegations of corruption.
r. *Non-availability of good NGOs:* Although there are good NGOs who have the competence and experience to do community level mobilization and encourage people's participation, there are several NGOs who are given charge of doing similar work, but do not have the required competence to carry out their stipulated functions. The consequence is a lack of adequate community involvement on the ground (as opposed to on paper), in schemes where people's participation is stipulated (e.g., in watershed management, irrigation management, forest management, among others).
s. *Water quality issues:* Water is a vast network of branching rivers, springs, creeks, swamps, estuaries, wetlands, lakes, bays, etc. Each water body can contain dramatically different levels of pollution. Water quality issues influence human and environmental health. Measuring base-level pollution in existing water bodies in different watersheds in the state to identify areas where new water-using industries (both as a source and a sink) can be located is rarely done or water quality is not monitored.

Way Forward

Having identified some of the challenges in water development and management in Nigeria, possible solutions or way-forward include:

i. *The Policy Framework and Existing Institution:* States in Nigeria have enormous quantity of water resources, surface and underground water, that requires a well-articulated administrative structure that can manage the resources effectively. The present position of management of water resources in Nigeria is grossly inadequate (Nwankwoala, 2011). The Federal, States and Local Governments have over the years been intervening from time to time in terms of the provision of potable water to the people. Federal Ministry of Water Resources, Petroleum Trust Fund (PTF), River Basin Authorities, DFRRI, National Water Supply Rehabilitation Project, National Borehole Programme and of course, the present government Legislative Boreholes are major players in this sector.
ii. *The need to improve coordination within government:* Although a significant amount of literature exists on laws, policies, and rules and regulations governing the provision of water supply services to the citizens of each state, there is a great need for clarity on roles and responsibilities within government institutions. Better coordination is needed both within government structures, and in the way in which government bodies interact with local communities for provision of water services. Greater coordination and streamlining within government departments needs to go beyond official statements affirming commitment to coordination, to implementing the changes required in the rules, regulations and procedures critical to effective coordination.
iii. *The need to build capacity at all levels:* Capacity building is vital at different levels within government institutions, as also within local communities, in order to improve the provision and maintenance of water resources services. These capacities do not only relate (as is commonly understood) to technical issues, but more importantly to a range of social, managerial and institutional issues from organizing effective community participation, building solidarity, vision and a sense of purpose within communities, and starting and running efficient community based organizations to dealing with government procedures and legal requirements and conflict resolution.
iv. *The need for effective involvement of local communities:* Even after capacities have been enhanced, there is a need to develop institutional space and mechanisms for governments and local communities to interact effectively. Official consultations with local communities need to be judicious in choosing between full participation and participation by representation, using existing democratic institutions. Explicit mechanisms have to be drafted into government rules and regulations, explained to concerned officials, and back-stopped by a capable body till it become accepted practice.
v. *The need for good quality information for decision-making:* Participation in decision-making is a means to an end, and the goal of informed decision-making requires good quality information on a range of issues, technical, social, economic, legal and institutional.

vi. *Efficient and judicious use of water resources:* Protection of water resources, drastic decrease in specific water consumption particularly in irrigation and industry, complete cessation of the practice of discharging waste water into the hydrological systems (such as, rivers and lakes), harvesting of precipitation and making a more efficient use of runoff.

Conclusion

In many regions of Nigeria, rising demand for water are forcing communities, stakeholders, and governments to explore new ideas and find new solutions that will help ensure stable, secure water supplies for future generations, and especially for sustainable agriculture. Just as the country is blessed with oil resources, it also has seemingly abundant water resources that are not being efficiently utilized. To provide fully effective water management, the capability to understand and predict the movement and availability of water within all components of the hydrological cycle and to be able to simulate the impacts of various landscape changes on the distribution and availability of water is essential. Effective water resources development and management must be underpinned by knowledge and understanding of the availability of the resource itself, the uses to which water is put and the challenges facing the managers at all levels of government. There should be protection of water resources, drastic decrease in specific water consumption particularly in irrigation and industry, complete cessation of the practice of discharging waste water into the hydrological systems (such as, rivers and lakes), harvesting of precipitation and making a more efficient use of runoff, use of water stored in lakes and underground aquifers.

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Evaluation of Nutrient Status of Olokoro Soils for Cassava / Upland Rice Intercropping System

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Abstract

Cassava and upland rice are important staple crops in Nigeria and commercially produced solely in most parts of Southeastern Nigeria; as a result of increase in population demand of both crops is on the increase. Based on this, there is need to intensify the production of both crops through intercropping system to meet up with the demand, therefore the nutrient status of Olokoro soils, Abia State southeastern Nigeria were evaluated for production of cassava and upland rice in an intercropping system. The soils were sampled with auger at 0-20 cm depth and the samples were taken to laboratory for analyses. The analytical results revealed that the soils have the following characteristics , soil texture, is sandy loam , pH, 4.9 , Organic Carbon, 20.8 g kg^{-1}, total N, 0.12 gkg^{-1}, P, 36.00 mg kg^{-1}, CEC, 3.10 cmol (+) kg^{-1} and Base sat, 38.00 % . Based on the nutrient status of the soils studied, suggestions were made and if adopted will result to an increase in production of both crops in an intercropping system.

Introduction

Cassava is an important crop and Nigeria is the highest producer of the crop in the world, with production rate of 57. 13 million metric tons (FAO, 2016). The crop plays a major role in the economy of the country as it supplies more than half the calorie intake of her inhabitants (Abam *et al.*, 2006) .And rice is an important staple crop in Nigeria and indeed most countries in the world. It is the sixth major crop in cultivable area after sorghum (*Sorghum bicolor*), millet (*Pennisetum spp*), cowpea (*Vigna ungiculata*), maize *(Zea mays*) and cassava (*Manihot spp*) It is estimated that 4.6 million ha of land could be put into rice cultivation in the country (Ukwungwu, 2000). These crops are produced as sole crops in most parts of Nigeria. Increase in the production of these crops through crop intensification is of strategic important to Nigeria, this is to cushion the effects of population pressure, enhance poverty reduction sustainable food and nutrition security and income generation. This led to the development of cassava and upland rice intercropping system by the Farming Systems Research Programe of the National Root Crops Research Institute, Umudike. Evaluation of the nutrients status of soils is helpful in the appraisal of the productivity of a such soils. This also assists in making recommendations for soil fertility management options to be adopted for yield increase of crops grown on the soils. Therefore, there is need to evaluate soils of Olokoro to ascertain the status of their nutrients for cassava and upland rice intercropping system. The objective of this study was to evaluate the nutrients status of Olokoro soils in southeastern Nigeria for cassava/upland rice intercropping system.

Materials and Methods

Study Area

The study area is Olokoro in Abia state southern Nigeria and it lies between latitude 5^0 45 to 49^1 N and longitude7^0 48 to 53^1 E. The climate is characterized by distinct wet and dry seasons. The wet season lasts for about seven months (April to October), with a mean annual temperature range between 22 and 31^0C, mean annual rainfall range of 1,570 to 2,800 mm, and relative humidity varying from 60 to 81 %. The vegetation consists of tropical rainforest. The underlying geology of the location consists of the Benin formation/unconsolidated sands and sandy clays (coastal plain sand).

Soil Studies

Two hundred sub soil samples were collected at the depth of 0-20 cm using auger from the study area and composited into ten composite samples. The samples were taken to the laboratory for physicochemical analyses. All the soil samples collected were air dried; gently ground and sieved using a 2 mm sieve preparatory for laboratory analysis. Samples for total N and organic C were passed through a 0.5 mm sieve.

Soil Analysis

The soil samples Soil were analysed for some physical and chemical proprieties using the standard laboratory methods as contained in the method of soil analysis by International Soil Reference and Information Center and Food and Agricultural Organization. **(**ISRIC and FAO, 2002).

Results and Discussion

The result from the analytical data (Table1) indicates that sand fraction dominated the particle size of the soils studied with a value of 814 g kg^{-1}, with silt particles having the least value of 38 g kg^{-1}. The higher sand proportion of the soils implies that basic cations such as Ca, Na, K and Mg would be leached more easily as texture determines the degree of retention or ease of leaching of basic cations (Wapa *et al*., 2013).

Consequently, it is an indication of high infiltration rate and low water holding capacity of the soils. This might result into moisture stress as was reported by (Fagbami and Udoh 1982). Furthermore, this condition encourages rapid leaching of nutrients from the soil beyond the rooting zone of the planted crops, a situation that threatens increase in food productivity and food security (Senjobi, *et, al.* 2013). The rather lower clay content in the soils could be attributed to the sorting of soil materials by biological and agricultural activities, clay migration or surface erosion by runoff or a combination of these (Malgwi *et al*., 2000). Therefore, there is need to incorporate plant residues and other organic materials into the soil to improve the aggregates quality of the soils, as this will lead to an increase in yields of the crops.

Generally, the textual classification of the soils agreed with optimum criterion of light medium loam sandy soil (Onyekwere *et al*., 2009) required for unhindered anchorage and bulking of roots and tubers including cassava and for easy harvest. The texture of the soils studied can as well retain enough moisture for upland rice production; these attributes give the indication that these soils are suitable for both cassava and upland rice production. The mean pH value of the soils is 4.9, an indication that they are slightly acidic and included among the excessively leached acid latosols with low to medium humus found in areas of rainfall approximately 2,200 to over 5,000 mm per annum in hot lowland (Udoh *et al*., 2013). According to Okusami *et al*. (1997) the acidity nature of the soils studied is an indication of influence of pre-weathered parent material on the chemical properties of some soils within the tropics. There is need to incorporate organic materials in the soils, to reduce the soil acidity. According to Onyekwere *et al* (2012), addition of organic fertilizer to soil reduces soil acidity because organic fertilizer has some liming effect on the soil. The low organic carbon content in the soils studied can be attributed to any or all of the following: inadequate supply of organic litter, bush burning, long dry season and intensive mineralization during the rainy season (Dogie *et al.,* 2008). Maintenance of a satisfactory organic matter status is essential to the production of most of the nitrogen and half of the phosphorus taken up by unfertilized crops, including cassava and rice (Von Uxekull, 1986). The total N content of the soils have a mean value of 0.12 , a value less than the critical level of 0.15 g kg^{-1} established for soils (Senjobi, *et al*., 2013). The low content of total N in the soils studied could be attributed to low organic matter of these soils, since inorganic N is accounting for only a small portion of total N in soils (Almu and Audu 2001). It could also be as a result of high rainfall that brought about leaching of soil nitrates (Eshett *et al.,* 1989). The total N content of the soils is a reflection of the organic carbon content of the soils. The low level also could be attributed to the intense cultivation of the soils which normally increases the rate of mineralization of organic matter, thus negatively affecting the level of soil total N content (Senjobi, *et al.,* 2013). There will be a positive response in yield increase of cassava and upland rice upon the application of Nitrogen fertilizer in the soils studied. The mean values of the available phosphorus obtained from the soils studied was 36.00 mg kg^{-1} . The value was far above the critical limit of 8.0 mg kg^{-1} P established for crops in southeastern Nigeria including cassava and rice (FPDD, 1989) and the critical level of 15 mg kg^{-1} P recommended by Thomas and Peaslee (1973) cited by Onyekwere *et al.* (2009). The result from the study confirmed the findings of Onyekwere et *al*. (2013). Who observed that soils derived from coastal plain sands contain moderate to high levels of available P. The mean value of exchangeable Ca of the soils studied had a value of 1.65 $cmolkkg^{-1}$. The value was below 4 cmol kg^{-1} regarded as lower limit for soils (Onyekwere *et al.,* 2001). The mean values of exchangeable Mg content of the soils studied was 0.58 cmol (+) Kg^{-1} , a value below the critical level (0.02 - 0.40 cmol (+) Kg^{-1} of exchangeable Mg in soils established by Adeoye and Agboola (1985). The low level of exchangeable Mg in the soils could be attributed to the nature of the parent material, as the total Mg content of the soils appeared to be influenced by the parent material and weathering (Osenwota *et al*., 2009). The mean value of exchangeable K was 0.07 cmol (+) Kg^{-1} , the soils had mean value below the critical limit of 0.20 coml (+)kg^{-1}, a value recommended for soils of southeastern Nigeria (FPDD, 1989, Enwezor *et al*.,1981), for production of cassava and upland rice. There will be a positive response in yield increase of cassava and upland rice upon the application of potassium fertilizer in the soils studied. The mean value of exchangeable Na was 0.09, a value below 0.20 cmol (+) kg^{-1} regarded as the critical value needed in soils (Amalu 1997). The low level of exchangeable bases in the soils studied could be attributed to as a result of soil loss through soil erosion. Mbagwu (1988) reported that soil loss through soil erosion had resulted in the deficiencies of exchangeable bases in soil. The result indicates that the Effective Cation Exchange Capacity of soils was low with a value of 3.80 and the value was below 20 cmol kg^{-1} regarded as being suitable for crop production if other factors are favourable (Onyekwere, *et al*., 2003), quoting FAO (1976). The low ECEC and nutrient reserves of the soils have been attributed to the fact that soils of southeastern Nigeria are strongly weathered, have little or no content of weatherable minerals in sand and silt fraction and have predominantly kaolinite in their clay fractions (FPDD 1989).

Conclusion

The soils are acidic, low in total N and exchangeable K and high in available P. The soil texture is favourable for production of the intercrops. For sustainable production of the intercrops organic manure including the harvested residues need to be incorporated to the soil and application of NPK at 90 Kg N, 20 Kg P_2O5, 75 Kg K_2 O ha^{-1} and 80 Kg N, 40 Kg P_2O_5, 40 Kg K_2O ha^{-1} fertilizer for cassava and upland rice respectively, are therefore recommended.

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Table 1: Mean values of the Physical and chemical properties of soils of the study area

Para meter	Value
Sand (g kg^{-1})	814
Silt (g kg^{-1})	38
Clay (g kg^{-1})	148
Textural class	SL
pH	4.9
Total N (g kg^{-1})	0.12
Organic Carbon (g kg^{-1})	20.60
Available P (mg kg^{-1})	36.00
Exch Ca (cmol(+)kg^{-1})	1.65
Exch Mg (cmol(+)kg^{-1})	0.58
Exch K (cmol(+)kg^{-1})	0.07
Exch Na (cmolkkg^{-1})	0.09
Exch Acidity (cmol(+)kg^{-1})	1.40
ECEC (cmol (+)kg^{-1})	3.80
% Base Saturation	38.00

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Description and Characterization of Some Alfisols under Two Different Land-Use (Groundnut and Maize) Patterns in Chanchaga, Minna, Niger State

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Abstract
Characterization of soils under two different types of land-use options - groundnut (GNL) and maize (ML) was carried out. An overview of the study area was obtained through a free survey technique. One profile pit was sank in each land-use option and described following FAO guidelines and soil samples were collected from each identified genetic horizon for laboratory analyses. The result indicates that the soils under GNL were brownish and well drained; while soils under ML were very dark grayish brown and poorly drained. The soils under both land-use options generally have favorable pH, high base status, but low to medium fertility status. The soils under GNL are classified as Typic Haplustalfs/Haplic Luvisol; while the soils under ML are classified as Aquic Haplustalfs/ Anthraquic Luvisol.

Introduction
Soil characterization gives a potent resource for the benefits to man in regard to food sustainability and environmental protection (Esu, 2004). It provides data on the potentials, constraints and distribution of major soils types. Agricultural landuse typifies the arrangements, activities, and inputs by individuals to produce, change and maintain a certain land cover for crop production and sustainability (Di. Gregoria and Jansen, 1998). Chanchaga (Minna) have great agricultural potential for both wet season and dry season farming due to its proximity to river Chanchaga. The major agricultural landuse in Chanchaga are suited for the cultivation of yam, maize, rice and groundnut. The study aims at providing and comparing data on the properties of some Alfisols under two different landuse (G/nut and maize) in Chanchaga, Minna, Niger State.

Methodology
The Study Area
The study area is located in Chanchaga, Minna, Southern Guinea savanna and lies within latitude 9º 31ʹ 54.94ʹ N and latitude 9º 31ʹ 21.4ʹ N, and longitude 6º 35ʹ 53.3ʹ E and longitude 6º 35ʹ 55.29ʹ E with elevation range of 209 m to 258 m above sea level. Two locations within the study area with different land-use options (G/nut and maize) were selected by free survey. The first location underground-nut land-use (GNL) was situated on a nearly flat land and lies within latitude 9º 31ʹ 50.12ʹ N and longitude 6º 35ʹ 58.64ʹ E. The second location under maize land-use (ML) was located on gently sloping land and lies within latitude 9º 31ʹ 38.69ʹ N and longitude 6º 36ʹ 4.08ʹ E. Minna falls under sub-humid tropical climate, with two distinct seasons, namely dry and rainy season. Minna possess an ustic moisture condition with mean annual rainfall of 1229 mm, and an isohyperthermic temperature condition. Its temperature (about 35ºC) remains high throughout the month of March and June (Ojanuga, 2006).

Field Study
A free survey technique was first carried out in the month of February and the first week of March 2017; in order to have an overview of the study site, and to generate information that could aid in the planning of the detailed field work. One profile pit was dug in each land-use location. The profile pits were described based on FAO guidelines for soil description and bulked soil samples were collected from each identified genetic horizons, and taken to the laboratory for analysis.

Taxonomic classification of the soils were according to USDA Soil taxonomy (Soil Survey Staff, 2014) and WRB for Soil Resources.

Laboratory Analysis

The soil samples were air-dried and sieved with 2 mm. The following soil physical and chemical properties were determined: Particle size distribution was by determined by the Bouyoucous hydrometer method, and textural classes established from the USDA soil textural triangle; Bulk density was determined by the undisturbed soil core method; Soil pH in water solution (soil ratio 1:1) was determined using the electrometric method; Soil organic carbon (OC) was determined by the wet dichromate method; Total N was obtained by the Macro-Kjedahl method; Available P was determined calorimetrically after Bray-1 extraction; Exchangeable bases (Ca, Mg, Na, K) was determined using 1N NH_4OAc extractant method, after which Ca and Mg was obtained from an Atomic Absorption Spectrometer, while Na and K obtained by the Flame Photometer; Exchangeable acidity (Al^{3+} + H^+) was determined by titremetric method; CEC was obtained by the NH_4OAc displacement; and base saturation (BS) calculated as follows:

$$BS = \frac{\text{total exchangeable bases}}{CEC} X\ 100$$

Results and Discussion

Morphological and Physical Characteristics

The field morphological and physical properties of the study area are presented in Table 1. The soils under GNL were well drained, while poor drainage condition featured in soils under ML. Soil colour varied predominantly from brown (7.5YR 4/4) in soils under GML to very dark grayish brown (10YR 3/1) in soils under ML. The structural groupings featured on surface horizons were massive structureless (ML) and moderate medium crumby structure (GNL). Sand particles were the dominant fractions in both soils, and generally decreased with depth in the soils; while clay particles alternately increased with soil depth. According to Fasina *et al.*, (2005) smaller size mineral particles usually increase down profile depths due to sorting, migration, and eluviation. Sand fractions ranged from 720 g kg^{-1} in surface horizons to 430 g kg^{-1} in sub-horizons (GNL), and 520 g kg^{-1} to 420 g kg^{-1} in surface and sub-horizons of soils under ML. Silt particles exhibited irregular pattern of increase and decrease down profile depth in soils under GNL, varying from 200 g kg^{-1} to 220 g kg^{-1} in surface and sub-horizons respectively. Both soils (under ML and GNL) also exhibited sandy loam texture on surface horizons. Generally the Bulk density values of the soils ranged from 1.41 g cm^{-3} to 1.55 g cm^{-3}, and were considered favorable for plant growth, falling within the range of 1.00 – 1.60 g cm^{-3} for mineral soils (Akapan-Idiok *et al.*, 2012).

Soil Chemical Properties

The field chemical properties of the study area are presented in Table 2. Soil pH increased irregularly with depth in the soils of GNL, but decreased irregularly in soils of ML, varying from 6.31 to 6.37 and 5.86 to 6.21 respectively. The soils are generally slightly acidic in reaction. Organic carbon content in the soils was generally low, and ranged from 2.59 g kg^{-1} to 8.18 g kg^{-1}. Land use activities such as livestock grazing, bush burning and the kind of arable farming in the area may have contributed to the low carbon content in the soils. For most Nigerian soils, optimum crop production can be achieved when critical level of carbon content stands at about 10 g kg^{-1} to 15 g kg^{-1} (Esu, 1991). Carbon values below this critical level may encourage more leaching losses of basic cations into sub-soils. Total N in all the soils were high i.e. > 0.2 g kg^{-1}. The application mineral fertilizers by the farmer in the area may have contributed to the high N values recorded in the soils. The N values generally ranged from 0.48 g kg^{-1} to 0.50 g kg^{-1} in surface horizon, and considered adequate for plant uptake. Distributions of available P contents in the soils (3.33 mg kg^{-1} to 3.50 in surface horizons) were irregular down the profile depths in both horizons and were considered low to moderate. The concentration of exch. bases (Ca, Mg, K, Na) in soils were also irregular in distribution across both profile depths. Ca ranged from 1.50 cmol kg^{-1} to 6.22 cmol kg^{-1}, Mg ranged from 0.36 cmol kg^{-1} to 1.04 cmol kg^{-1}, Na ranged from 0.21 cmol kg^{-1} to 0.24 cmol kg^{-1}, and K ranged from 0.05 cmol kg^{-1} to 0.13 cmol kg^{-1} on surface horizons. CEC ranged from 5.80 cmol kg^{-1} to 9.40 cmol kg^{-1} in soils under ML, and 3.20 cmol kg^{-1} to 5.40 cmol kg^{-1} in soils under GNL. The soils generally exhibited high base saturation values (66.3 % to 91.2 %). The base saturation values of the soils agrees with the results of Lawal *et al*., (2012) and Afolabi *et al.*, (2014) that the soils of Minna have high base saturation values. High base status of the soils shows that basic nutrients may occur in available form for plant uptake despite low cation reserve in the soils (Aki *et al.*, 2014).

Table 1: Morphological and Physical properties of the Soils

Profile/ landuse	Horizon Designa Tion	Profile Depth (cm)	Soil Colour (moist)	Mottles	Consistence dry	moist	Structure	Sand →	Silt kg g^{-1}	← Clay	Textural Class	Silt/Clay Ratio	Bulk density (g cm^{-3})
PGNL	Ap	0-28	7.5YR4/4 (B)	-	s	v.fr	2m cr	720	200	80	SL	2.50	1.47
	Bt1	28-104	5YR 4/6 (YR)	-	h	fi	2m sb	420	180	400	SL	0.45	1.53
	Bt2	104-166	5YR 4/6 (YR)	2.5YR3/6 (DR)	h	fi	2mc sb	440	260	300	CL	0.87	1.55
PML	Ap	0-32	10YR 3/1 (VDGB)	-	v.h	fi	Ms	520	340	140	SL	2.43	1.49
	Bt	32-75	10YR 4/2 (DGB)	10YR 5/4 (YB)	h	fi	1m sb	420	380	200	L	1.90	1.41

Table 2: Chemical Properties of the Soils

Profile/ landuse	Horizon Designation	Profile Depth (cm)	pH (H_2O)	OC (g kg^{-1})	Total N (g kg^{-1})	Avail P (mg kg^{-1})	Ca	Mg	K	Na	Exch. Acidity	CEC	BS (%)
							← cmol kg^{-1} →						
PGNL	Ap	0-28	6.37	4.49	0.48	3.33	1.50	0.36	0.05	0.21	0.60	3.20	66.3
	Bt1	28-104	6.24	3.79	0.39	1.75	3.52	0.43	0.10	0.31	0.40	5.40	80.7
	Bt2	104-166	6.31	2.59	0.39	2.45	3.76	0.39	0.10	0.29	0.60	5.80	78.3
PML	Ap	0-32	6.05	6.38	0.50	3.50	6.22	1.04	0.13	0.24	0.40	8.50	89.8
	Bt	32-75	5.86	8.18	0.50	3.15	6.83	0.87	0.14	0.22	0.80	9.40	85.7
	*	75-105	6.26	4.39	0.45	4.03	4.79	0.53	0.07	0.20	0.60	6.70	83.4
	*	105-135	6.21	6.58	0.25	4.20	4.58	0.37	0.09	0.25	0.40	5.80	91.2

PGNL = soil profile under Groundnut land use; PML = soil profile under maize land use; * auger sample depth

Conclusion

Under the USDA soils taxonomy, both soils under GNL and ML are classified as Ustalfs at Suborder level, and Haplustalfs at Great group level. However, under Subgroup level, the soils are classified as Typic Haplustalfs (GNL) and Aquic Haplustalfs (ML). The soils are also classified as Haplic Luvisol (GNL) and Anthraquic Luvisol (ML) under WRB for soil resources. The soils of the study area generally have favorable pH, high base status, but low to medium fertility status. However, with adequate application of mineral fertilizers and organic inputs, the soils can be more productive. Soils of ML will require the installation of drainage structures in order to manage the poor drainage condition of the location.

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Fertility Capability Classification: Calibration of Soil Fertility Classes from the Sokoto-Rima Flood Plain, Nigeria

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Abstract

The study was conducted in the Sokoto-Rima flood plains at Sokoto Nigeria, with the aim of calibrating the soil Fertility Capability Classes (FCC) obtained in the previous work (Yakubu et al, 2008) with fertilizer Nitrogen response for appropriate and sustainable agricultural landuse. Soil samples from the two fertility classes delineated (Yakubu et al, 2008) were prepared and used for pot experiment in the screen house to compare crop response using nitrogen rates (0, 40, 80 and 120kg N) and maize (Zea mays) as test crop. Results show that although there was no significant statistical difference between the two soil classes, absolute figures show that soil class Lghm (Loamy soils, low in organic matter with gleying and pH limitation) has higher fertility/yield potential followed by the class Lgm (Lgm- Loamy soils low in organic matter with gleying limitations)/ Sgm class (Sandy soils low in organic matter and with gleying limitations). Periodic monitoring of soil quality, adding organic manure and applying ameliorative measures such as liming can improve and sustain the productive capacity of the soils.

Keywords: Fertility classes, Calibration. Soils and Floodplains

Introduction

The fertility of a soil is related to its capacity to store, retain and release plant nutrients in such kinds and proportions as are required for crop growth. This soil quality can be derived from a combination of many soil properties: Organic matter content, clay content and clay mineralogy, presence of weatherable minerals, pH, base saturation and biological activity (FAO, 1993). While most crops thrive best on fertile soils, some do yield reasonably well on moderately fertile soils (FAO, 1993). In Nigeria, one of the major problems of farmers is poor fertility replenishment strategy that could allow for a sustainable agricultural productivity (Mutsaers, 1990). In its effort to reduce this problem, the Federal Government, through its policies on creating enabling environment for agricultural production to smallholder farmer, once introduced fertilizer subsidies so that farmers could afford the fertilizers for replenishing the fertility of their soils. This policy further aggravated the problem because farmers fertilize their soils without the knowledge of the basic fertilizer nutrient requirement and capacity of their soils. This results in a lot of wastage of fertilizer and possible inhibition of the activity of other nutrient elements in the soil, rendering some soils physiologically deficient of certain nutrient elements. The need for FCC therefore arises out of the identified technical problem of fertility maintenance in our fragile soils and the need for technology to improve fertility management of Nigeria soils, particularly Sokoto State soils. The paper aimed to identify appropriate scientific fertility management strategies for a sustainable agricultural land use in the Sokoto flood plains so as to increase food security in Sokoto state with the following objectives: to calibrate the FCC classes shown on the map using fertilizer regimes and maize (*Zea mays*) as a test crop and interpret the calibrated FCC classes so as to assist in land use management of the flood plains

Materials and Methods

Location of Study Area

The study was conducted in a representative area 100ha (1km^2) out of 3600ha of the Sokoto Rima floodplains located east of University road in Sokoto environment (13^{o}1'N, 7^{o}E) (Bashir and Duru, 2000). The area is located in the Sudan savanna vegetation zone of the semi-arid sub-Sahara region of Africa where a long dry (October-May) season and short (June-September) rainy seasons prevail (Bashir and Duru, 2000). It is characterized by a cold dry spell (November-January) in the harmattan period and a hot dry spell in February-May. The mean annual rainfall is about 400-700mm, which is often erratic in distribution (Singh, 1995). Temperatures according to Arnborg (1988), ranges between 15°C during the cool nights, to 40°C during the warm days. The mean annual temperature is about 27°C. The soils are poorly drained in a relatively flat topography. They are prone to seasonal water logging and usually show gleying within 1metre of the surface.

Treatments and Experimental Design

Composite soils of the two FCC classes obtained from the study area were used for pot experiment in the screen house to determine the dry matter yield of maize (Z*ea mays).* Four (4) levels (0, 40, 80 and 120kg N ha^{-1}) of nitrogen as urea were administered as treatments in order to determine the appropriate rates of N application suitable for the FCC classes. Treatments consisted of two (2) FCC classes (Se and Le soils) with four (4) N rates (0, 40, 80 and 120kg N ha^{-1}) making 12 treatment combinations. The 12 treatment combinations were laid out in a completely randomized design (CRD) replicated three (3) times making a total of 36 treatment combinations.

Soil preparation and Potting

The air dried and sieved soil samples were composited in accordance with the determined FCC classes and mixed thoroughly before potting. Small portions of the samples were oven dried to determine the moisture content to confirm the extent of drying. Three kilograms of soil of the two different FCC classes (Se and Le) were weighed in each of the 36 pot. Filter papers were placed at the inner bottom of the pots to reduce loss of soil through drainage holes.

Planting Materials and Planting

A local cultivar of maize (English: Sweet Maize. Hausa: Jan masara) was sourced from the farmers cultivating the flood plains, and was used for the pot experiment. Planting was done at a depth of 2.5cm. three seeds were planted in each pot, which were later thinned to one plant per pot after emergence. Fertilizer P as single super phosphate (SSP) was applied basally during potting at the rate of 40 Kg ha^{-1}

Fertilizer Application, watering and pest control

Amount of fertilizer N (0, 40, 80 and 120kg N /ha^{-1}) to supply the nutrient under test were applied two weeks after planting as top dress 5cm deep and covered with soil. Water was added every day to moisten the entire soil volume. Care was taken not to add excess water to avoid infection by damping off organisms. There was no incidence of pests and diseases throughout the period of the experiment.

Data collection

Data on growth parameters like plant height, number of leaves per plant and dry matter accumulation were collected from each pot. The number of leaves in each pot was counted and recorded every week from two weeks after planting. Plant height was determined by measuring the height of the plants from the soil surface to the tallest leaf using a meter rule, every week from two weeks after planting (WAP). Dry matter accumulation was determined by harvesting the aboveground biomass in each pot and oven dried to constant weight at 65°C for 48hours at 7 WAP.

Statistical Analysis

Data generated was subjected to analysis of variance, and means separated using least significant difference (lsd)

Results and Discussion

The FCC Map

The FCC map and the physical, chemical and morphological characteristics of the different FCC classes were discussed in details in Yakubu et al, (2008). This paper therefore describes it in brief. Three symbols are shown on the map, (Fig. 1) which denotes the FCC units that commonly occur in the Sokoto-Rima flood plain represented by the study area. They are *Leg, Legh*, and *Seg* in order of extent. The *Le* and *Leh* constitute the dominant FCC units. There also some minor areas of *Se,* and *Sek* as inclusions within the dominant soil units.

a. *Leg*

They are well cultivated. They have high water holding capacity because of their high silt content and medium infiltration capacity. They also exhibit redoximorphic properties close to the surface.

They are however prone to surface sealing because of the high silt content. Moreover, they have low ability to retain nutrients against leaching. They are in association with patches of *Seg,*.

b. *Legh*

This FCC unit, Legh, is very similar to the Leg, except that it is found in association with small patches of Ceg and Seg. It differs from the Leg only by having a strong to moderate acid problem. Acid problems affect nutrient availability to plants and microbial activities in the soil.

c. *Seg*

This FCC unit contains soils that occupy in the basin of the flood plains with inclusions of Sek patches. They are coarse textured well-drained soils. They have low water holding capacity and high infiltration rate

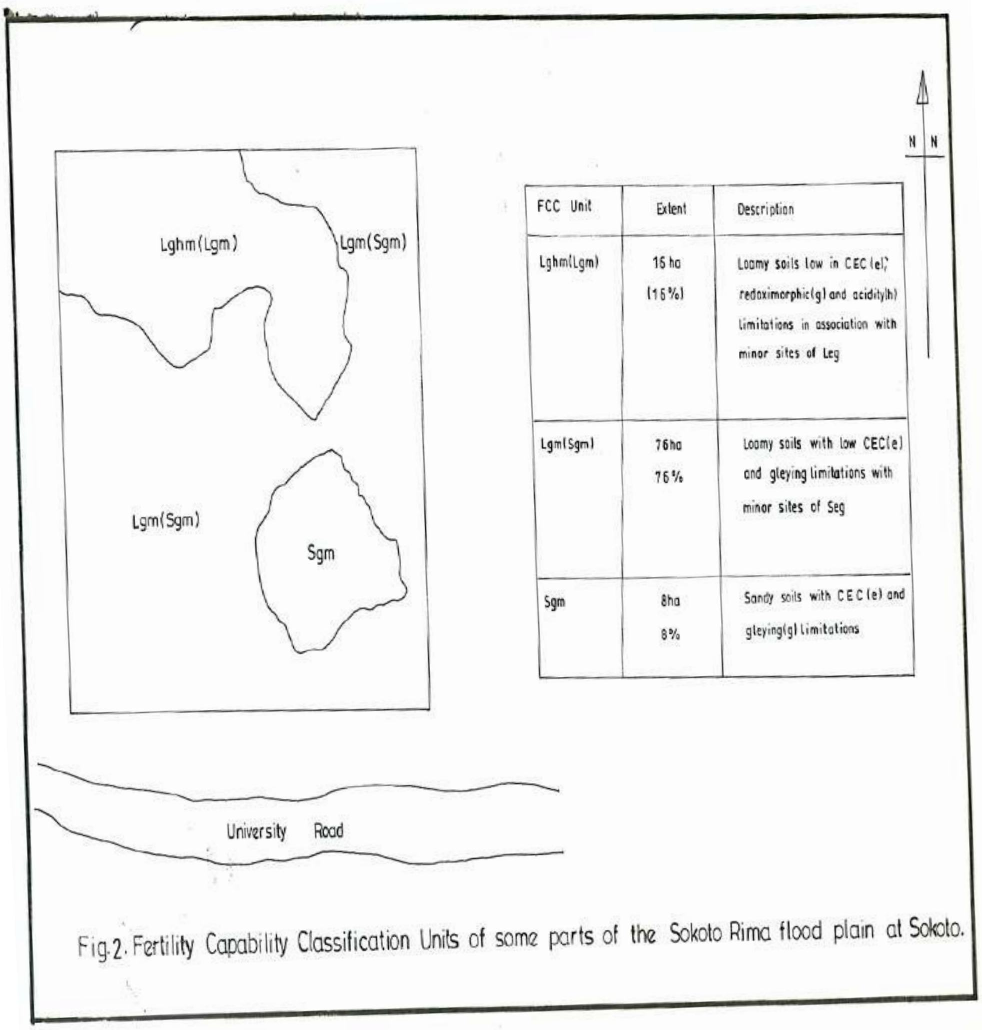

Fig.2. Fertility Capability Classification Units of some parts of the Sokoto Rima flood plain at Sokoto.

Figure 1: Free sketch map showing the three FCC classes which were resolved to two soil units.
Source: Yakubu et al, (2008)

The results of plant height (Table 1.) showed that the fertilizer rates had no effect on plant height at 2 weeks after planting. This could be due to the plant's dependence on appreciable quantities of mineral nutrients stored in the seed before proper root establishment as indicated by Singh, (1995) The effect of the fertilizer rates started to manifest significantly ($P<0.05$) at 3 weeks after planting (3 WAP). At 4 to 6 WAP, the effect was highly significant. This implies that N was deficient in the soils under test. In other words, N is highly critical at vegetative growth stage. Generally, the table indicates that throughout the growing period, nitrogen applied at the rate of 40Kg ha^{-1} gave the highest height (35.23cm), followed by N applied at 80Kg ha^{-1} (30.217cm) and control (N0)

(27.500cm). The lowest being N applied at 120Kg ha^{-1}(24.500cm). This could be due to the cultivar of maize being local and cannot respond to N rates above 80kg/ha^{-1}. it could also be due to low CEC of the soil and the dilution of P and K nutrient elements by the N rates, that appeared to be higher than the other inherent nutrients especially the highest rate (N120) that is suspected to be responsible for P and K deficiencies,

Table 1: Effect of N rates and soil type on plant height

Treatment	Plant height (cm)					
N. (Kg N ha-^{1})	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP
N0	18.25	22.00	24.92ab	25.75bc	25.83b	27.50bc
N40	20.75	25.83	27.58a	29.45a	31.75a	35.23a
N80	18.92	25.00	27.63a	29.23ab	30.05a	30.22ab
N120	18.25	21.47	22.83	23.75c	24.42b	24.50c
Sig.	ns	ns	*	**	**	**
LSD			3.702	3.593	3.700	5.655
FCC Type						
Le,	18.81	22.53	24.92	26.40	27.32	28.83
Se	17.78	24.63	26.57	27.69	28.71	29.9
Sig.	ns	ns	ns	ns	ns	ns
LSD						

Means in a column followed by similar letters in a treatment group are not significantly different at 5% level of significance

The effect of N rates and soil types on number of leaves per plant (Table 3) showed that N rates influenced significantly the leaf production at 2 and 3 WAP. But there was no significant effect of the N rates at 4 to 6 WAP. However, at 7WAP the influence of the N rates was highly significant. The two soil types had no statistical significant effect on leaf number. However, in absolute terms the loamy soils performed better than the sandy soils relative to number of leaves produced from maize grown in them. This result implies that as from germination to 3 WAP the plants absorbed significant quantities of N for leaf production. But from 4WAP the N absorption was then significant for plant height (table 2.). At 7WAP, fertilizer N was again significantly used for leaf production. This dwindling situation could be because of the low content of P and K over N rates which caused nutrient imbalance.Generally pots supplied with 40kg and 80kg N h^{-1} produced the highest number of leaves (10 leaves) throughout the growing season, 0 Kg N ha^{-1} (8 leaves) and 120 kg N ha^{-1} (7 leaves), which were not statistically different at 7 WAP. Although not statistically significant, absolute values indicated that Se soil type gives better conditions for the growth of the crop than Le. .This is because it is well drained and can allow good aeration at the root zone. The results of the effect of N rates and soil type on dry matter (Table 3.) shows that N rates affected significantly the production of above ground and root dry matter. Throughout the growing period, N rates contributed significantly in the production of above ground dry matter. High significance was recorded on root dry matter. This implies that, of the assimilates produced due to N rates, larger concentrations were partitioned to the roots than the shoot. This was probably done to increase root development and network (Singh, 1995). The two soil types had no effect on dry matter accumulation although absolute values show little variation. This implies that the soils were statistically the same. The results show that 80kg N ha^{-1} produced the highest dry matter (4.2g), followed by 120 kg N ha-1 (4.11g), 40kg N ha^{-1} (3.4g) and 0kg N ha-1 (1.9g), which were not statistically different.

Table 2: Effect of N rates and soil type on Number of Leaves

Treatment	Average Number of leaves/ Plant					
N.Kg N ha-1	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP
N0	4.0ab	5.0ab	6.0	7.0	7.0	8.0bc
N40	4.0a	6.0a	7.0	8.0	8.0	10.0a
N80	4.0a	6.0a	7.0	7.0	8.0	10.0ab
N120	3.0	5.0b	6.0	7.0	7.0	7.0c
Sig.	*	*	ns	ns	ns	**
LSD	0.71	0.93				1.1
FCC						
Le	4.0	5.8	6.8	7.5	8.4	9.4
Se	4.42	5.7	6.5	7.5	7.9	8.8
Sig.	ns	ns	ns	ns	ns	ns
LSD						

Means in a column followed by similar letters in a treatment group are not significantly different at 5% level of significance

Table 3: Effect of N rates and soil type on Dry matter

Treatment	Dry matter (g)		
Nitrogen rate Kg N/ ha-1	Above ground	Root	Total Dry matter
N0	0.7b	1.2b	1.9c
N40	1.2a	2.2a	3.4b
N80	0.7b	0.8b	4.2a
N120	0.4b	0.6b	4.11ab
Sig.	*	**	**
LSD	0.5	0.9	1.3
FCC Unit			
Le	0.8	0.9	1.7
Se	0.7	1.5	2.2
Sig.	ns	ns	ns
LSD			

Means in a column followed by similar letters in a treatment group are not significantly different at 5% level of significance

Fertilizer Response Curve.

Figure 2 shows the response of N rates applied to the corn on dry matter. The figure indicated dry matter accumulation of 1.33g from zero to 3.4g when N was applied up to 40k N ha-^{1} and rose to 4.2g at 80kg N ha-1. Application at 120kg N ha-^{1} rate yielded 4.11g which indicated a gradual dry matter yield decline.

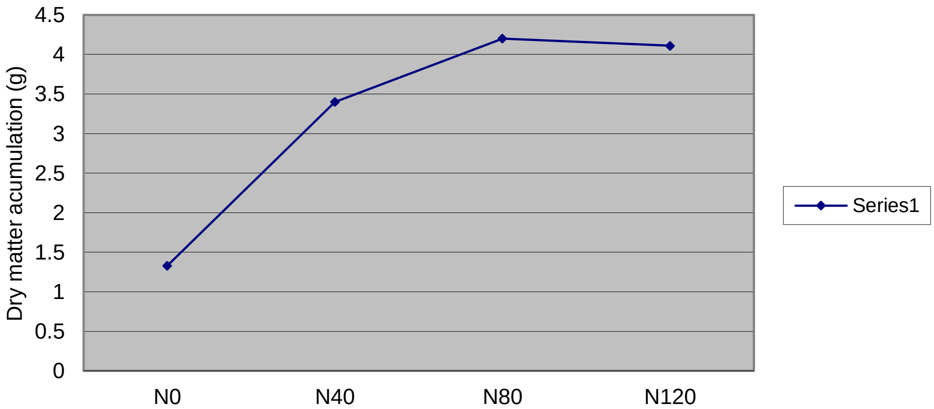

Figure 2: Response curve on the effect of N rates on dry matter yield

This implies that if the limitations of the soil FCC classes are not managed, application of fertilizer N at rates above 120 kg N ha^{-1} may result into economic wastage.

Conclusion

Results show that after calibration with four N rates (N0, N40, N80 and N120), the fertilizer response curve indicated that applying N above 80kg N ha^{-1} resulted into yield decline and that the two soil FCC classes were statistically the same in terms of fertility status. In the light of the above findings, there is need for regular addition of plant residues and organic manures the soils in order to check soil erosion and improve the physical conditions and fertility of the soils is necessary to improve CEC and contribute nutrients especially P and N. Ameliorative measures like liming and addition of gypsum to classes with pH, K and Na problems. Cultivate salt tolerant crop. Periodic monitoring of soil and water quality in the area so that appropriate ameliorative measures could be embarked upon as and when due.

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Physical And Chemical Characteristics Of Surface And Sub-Surface Soils Of Mining And Dump Sites In Abia State

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Abstract
This study investigated the soil physical and chemical characteristics of surface and sub-surface soils of mining and dumps sites in Abia State. The soil samples were collected from two different refuse dump (Ntigha dump; ND site, and Ariaria dump AD site) and two mining sites (Leru mining- LM site, and Ohiya mining-OH site,). A total of forty (40) samples were collected at random, ten (10) per site at the depths of 0-20 and 20-40 cm. The soil chemical and physical characteristics studied include: soil pH, organic carbon, total nitrogen, particle size, bulk density, total porosity and Ksat. The laboratory data collected were subjected to analysis of variance (ANOVA) for experiment in Randomized Complete Block Design (RCBD). The mean was separated using fisher's least significant difference at a probability level of 5%. The result obtained indicated that the particle size distribution (% sand, silt and clay particles) of Leru mining site was significantly ($p \leq 0.05$) different from Ohiya mining site, Ntigha dump site and Ariaria dump site. Ohiya mining site had the highest bulk density of 2.02 and 2.18 mgm^{-3} at both surface and subsurface soils depths, it also had the lowest total porosity of 23.77% and 17.74% at surface and subsurface depth. Generally the bulk density of the soils increased significantly ($p < 0.05$) in the lower depth, total porosity decreased significantly ($p \leq 0.05$) in the lower depth. Similarly Ksat decreased in the lower depth. The Ariaria dump site had the highest pH value (6.20 and 5.90), organic matter content at the lower depth, compared to the other sites with low aluminum and hydrogen ion content. Generally the study indicated that the dumping of refuse in the Ariaria and Ntigha sites could have impacted positively on physical and chemical properties studied while mining activities in the Leru and Ohiya sites impacted negatively on the soil properties studied.

Keywords: Mining and dump sites, organic carbon, Soil pH, bulk density, Ksat

Introduction
Mining involves the movement of large volumes of soil from the surface of the earth and removal of large amounts of regolith and rock to extract valuable ore. In some areas, this has been occurring for a considerable period of time (50 years) (Banning *et al.,* 2008; Koch, 2007). The common practice in a mine site is the mounding of soil into piles and storage until the mining operation is complete (Banning *et al.,* 2008; Ingram *et al.,* 2005). On a global scale about 20 percent deforestation in developing countries may be attributable to mining (Bahrami *et al.,* 2010). Ghosh (1990) reported that every one million tons of coal extracted by surface mining methods damages a surface area of about 4 ha. Mining soil has high content of rock fragments in comparison to fine earth. Mining activities disrupt partially or totally the original characteristics and qualities of soils and re-set the pace of soil formation. Mining influences soil physical and structural properties (Shukla,*et al.,* 2004). Generally, mining affects the available land suitable for cultivation (Banerjee *et al.,* 2004; Dutta and Agrawal., 2002; Ghose, 1996; Singh *et al.,*2006). These spoils are not suitable for both plant and microbial growth because of low organic matter content, unfavorable pH (Agrawal *et al.,*1993; Burgharadt, 1993; Rodrigue and Burger, 2004) which affects the drainage system and prevent natural succession of plant growth, increases water stable aggregates and initiates differences in water stable aggregation among soil horizon(Wali, 1987; Gorman and Sencindiver, 1999; Thomas *et al.,* 2000;Wilson *et al.,*2002; De and Mitra.,2002).Mined soils can

have poor water retention resulting from high coarse fragment content, lack of fine earth, poor soil structure which allow water to drain quickly from the soil profile, disturbs farmland, forests and waterways (Rodrigue and Burger, 2004), increases water stable aggregates (Thomas *et al.,*2000) and initiates differences in water stable aggregation among soil horizons(Gorman and Sencindiver, 1999). In the process of mining, several changes of the physical and structural properties, chemical and microbiological properties of soils occur (Reich *et al.,*2001; Shukla *et al.,* 2004). The most common method of waste disposal is dumping on land, because it is the cheapest method of waste disposal. However, this requires large area and proper drainage. The land disposal of municipal and industrial solid waste is potential cause of soil degradation, groundwater contamination and soil pollution. Unscientifically managed dumping sites are prone to groundwater contamination which invariably results in chemically unfavourable soil status that influence immediate environment for crop productivity. Therefore, the specific objectives of this study are to determine the soil physical and chemical characteristics of surface and subsurface soils of mining and dump sites in Abia state and correlate the soil properties of the soil studied.

Materials and Methods

Site description

The study was carried out in two different sites of mining and dump sites in Abia State. The first site is a Kaolin mining site located at Ohiya community in Umuahia south LGA, Ohiya is located near the Abia Tower junction on the Umuahia Enugu-Portharcourt express way, lies at latitudes 05^{0}26N and longitude 07^{0}22E, this area is characterised by high temperature with an altitude of 92m above sea level. The second mining site is located at Leru Umuneochi LGA. In this site, sand and gravels are mined, and lies between latitudes 05^{0}30N and longitude 07^{0}20 E. The area is sparsely populated and occupies areas of farm land with an altitude of 3m above sea level. The dumping sites are located at Ntigha along Umuahia-Enugu Portharcourt express way in Isialangwa North LGA, lies at latitude 05^{0} 27'N and longitude 07^{0} 24'E with an altitude of 147m above sea level. The second dumpsite is located at Ariaria international main market at Aba-Portharcourt express high way in Aba north LGA. Lies at latitude 05^{0}06'N and longitude 07^{0} 19'E with an altitude of 59m above sea level.

Sample collection and laboratory analysis

Soil samples were collected from these locations using core sampler and soil auger at surface 0-20cm and subsurface 20-40cm levels, ten (10) samples were collected from each land use and the disturbed samples were air dried at room temperature and passed through a 2mm sieve mesh. The sample was subjected to the following laboratory analysis: Soil particle size distribution was determined by the hydrometer method Bouyoucus, (1951). Bulk density was determined using (Anderson and Ingram, 1993). Soil pH was determined with pH meter in water (McLean, 1982). Organic carbon was determined by dichromate-oxidation method of Walkley and Black wet oxidation method as described by Nelson and Somner (1982), organic matter was calculated by multiplying organic carbon with Van Bremmelen factor (1.724). Total nitrogen in the soil sample was determined by the Micro-Kjeldahl method (Brookes *et al.,* 1985).

Statistical analysis

The data collected was subjected to analysis of variance (ANOVA) for experiment in Randomized Complete Block Design (RCBD). The mean was separated using fisher's least significant difference at a probability level of 5%.

Results and Discussion

Particle size distribution

The particle size distribution of the soils studied as shown in Table 1. Showed the texture of soil under the three land use systems was sandy loam except under Ariaria dumpsite (AD) at the surface which had loamy sand (LS) texture. At both depths, the highest sand contents were observed under Ariaria dumpsite (AD), while Ohiya mining site (OM) had the lowest. With regard to the silt contents, Leru mining site (LM) and Ntigha dumpsite (ND) recorded the highest at surface depth, while Leru mining site (LM) recorded the highest depth. Ohiya mining site (OM) recorded the lowest at the surface. Whereas, Ntigha and Ariaria dumpsites were observed to have the lowest OM at the sub-surface. The highest clay contents were observed under the Ohiya mining site at both surface and sub-surface depths. The lowest clay contents at both depths were observed in Ariaria dumpsite. Generally, the sand content decreased with depth, while the silt and clay

contents increased. However, the silt content of Ariaria dumpsite (AD) and the clay content of Leru mining site (LM) did not change. As shown in Table.1, and with regards to surface and sub-surface depths, the particle sizes were significantly ($P \leq 0.05$) different. With regards to the land use systems and depths, the sand, silt and clay particles of Leru mining site (LM) were significantly ($P \leq 0.05$) different from OM, ND and AD. Generally, the sand, silt and clay particles of Ariaria dumpsite (AD) were significantly ($P \leq 0.05$) different from others in both surface and sub-surface depths. The high sand contents of both the mining and refuse dump sites could be attributed to the geology of the area. The geology of the area is unconsolidated sand deposits formed over coastal plain sand which are characterized by sandy soils over a wide land area (Asawalam *et al*., 2009). The variations in particle sizes with depth could be as a result of the pedogenetic processes of eluviation and illuviation (Chukwu, 2012). The high sand, low clay and silt contents, observed in refuse dump sites, corroborated the report of Ideriah *et al*. (2006), who reported sandy loam texture for a refuse dump site in Porthacourt, Rivers State. Anikwe and Nwobodo (2002) and Ideriah *et al.* (2006) observed that dumping of household municipal wastes resulted to high sand, low clay and silt contents leading to a sandy loam texture. The increase in clay content with increasing soil depth maybe due to translocation, (Agoume and Birang, 2009), dissolution, and leaching of clay materials as a result of intense torrential rainfall, argillation of clay, lessivage and sorting of soil materials (Ojanuga, 2013). The bulk density and total porosity of the soils studied are shown in Table 2. At both depths, Ohiya mining site (OM) had the highest bulk density. The lowest bulk density was observed in Ariaria dumpsite at both depths. With regard to total porosity, AD had the highest TP. Ohiya mining site (OM) was observed to have the lowest total porosity. Generally the bulk density of the soils increased significantly ($P \leq 0.05$) with depth, whereas total porosity decreased significantly ($P \leq 0.05$) with depth (Table 2). These observations reflected the influence of organic matter on the parameters. With reference to land use systems in both surface and sub-surface depths, the bulk density of Ohiya mining site (OM) was significantly ($P \leq 0.05$) higher than LM, ND and AD. The total porosity under OM was significantly ($P \leq 0.05$) different from LM, ND and AD at both depths.
The variation in bulk density, total porosity and aggregate stability may be attributed to the level of organic matter in the soil (Ahukaemere *et al.,* 2012). The organic materials in the mining sites and municipal wastes help to increase the soil matrix thereby reducing soil bulk density and consequently increasing total porosity and aggregate stability.

The Correlation between soil properties under investigation
The correlation result (table 3), indicated that sand correlated ($P<0.05$) negatively with silt and clay. Sand has negative influence on silt and clay fraction content. This may have resulted from the nature of soil parent material, illuviation and eluviations (Chukwu, 2012). Soil pH correlated negatively with clay ($P<0.05$) and positively with sand ($P<0.05$). While phosphorus was positively correlated with sand and pH ($P \leq 0.05$).The positive correlation between pH and sand indicates the influence of pH on the sand. Also the positive correlation between phosphorus, sand and pH indicate that in acidic soil, P is fixed. Hence it is influence by sand and low pH of the soil Aluminium (Al) was also negatively correlated ($P<0.05$)with sand, pH and phosphorus and positively correlated ($P<0.05$) with clay. The negative correlation between Al, sand, P and pH indicates Al exerts a negative influence on sand, P, and pH properties of the soil by fixing phosphorus, increase soil acidity with increased sand content (Anderson-cook *et al.,* 2002). Hydrogen was negatively correlated ($P \leq 0.05$) with sand, pH, P, and OM while H correlated positively with clay and Al. The negative correlation between H^+, pH, P, OM and sand indicates the effect of H+ influence in the soil acidity, fixing of P, low content of OM, while the positive correlation between H^+, clay and Al indicates the nature of the clay mineral in the soil (Jegede *et al.,* 2011). Ksat negatively ($P \leq 0.01$) correlated with sand, P and bulk density and correlated ($p<0.01$) positively with silt. Ksat increases the silt content thereby decreasing the soil bulk density and increases the P content of the soil.

Conclusion
The results of this study showed variations in some of the measured soil properties in the different sites. To some extent the waste had positive and negative influence on the surface and subsurface properties studied. The OM site recorded the highest bulk density at both depths (0-20 and 20-40cm). We observed that the soils from the dump sites (AD and AD) had good potentials for arable

crops since the physical, chemical and moisture characteristics observed are indicative of the high fertility potentials in these soils.

Table 1: **Particle size distribution of soils studied**

Land use	Sand	Silt (gkg^{-1})	Clay	TC
		0 – 20 cm		
LM	758.0	122.0	120.0	SL
OM	738.0	102.0	160.0	SL
ND	778.0	122.0	100.0	SL
AD	818.0	112.0	70.0	LS
Mean	773.0	114.5	112.5	
		20 – 40 cm		
LM	718.0	162.0	120.0	SL
OM	698.0	122.0	180.0	SL
ND	768.0	112.0	120.0	SL
AD	778.0	112.0	110.0	SL
Mean	740.5	127.0	132.5	
$LSD_{0.05}$				
Land use	8.2	3.9	7.9	
Depth	11.6	6.8	4.1	
L × D	3.8	5.5	1.9	

(a) LM = Leru mining site, OM = Ohiya mining site, ND = Ntigha dump site, AD = Ariaria dump site L × D = Interaction of land use × depth.

Table 2: **Bulk density and total porosity of soils studied**

Land use	Bd ($Mg\ m^{-3}$)	Pt (%)
	0 – 20 cm	
LM	1.92	27.55
OM	2.02	23.77
ND	1.88	29.06
AD	1.79	32.45
Mean	1.90	28.21
	20 – 40 cm	
LM	1.95	26.42
OM	2.18	17.74
ND	1.96	26.04
AD	1.82	31.32
Mean	1.98	25.38
$LSD_{0.05}$		
Land use	0.11	1.59
Depth	0.02	1.04
L × D	0.17	1.10

LM = Leru mining site, OM = Ohiya mining site, ND = Ntigha dump site, AD = Ariaria dump site, Bd= bulk density, Pt= total porosity, MWD= mean weight diameter, DR= dispersion ratio L × D = Interaction of land use × depth.

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Figure 1: Ntigha Dump site (Lat. 05^0 30'N. Long. 07^0 29' E)

Figure 2a: Undisturbed soil of Ohiya Mining site(Lat. 05^0 26'N. Long. 07^0 22' E)


Figure 2b: Disturbed soil of Ohiya Mining site (Lat. 05^0 26'N. Long. 07^0 22' E)

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Uptake Characteristics of Lead (Pb) and Cadmium (Cd) by Turmeric (*Curcuma longa* Linn) as Influenced by Single and Mixed Pb and Cd Treatments

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Abstract
Greenhouse experiments were carried out to study the uptake of lead (Pb) and cadmium (Cd) by turmeric (Curcuma longa Linn) plant. The experiment investigated how adding Pb and Cd singly and simultaneously to Amakama and Ajata-Ibeku soils affected turmeric uptake of Pb and Cd. Results obtained revealed that Amakama soil had a sandy clay loam texture and Ajata-Ibeku soil a clayey texture. In Ajata-Ibeku soils, the values of effective cation exchange capacity (ECEC), pH, clay and organic matter (OM) were higher than the corresponding values obtained in Amakama soils. Background values of Pb and Cd were 26.30 and 1.05 mg/kg, respectively in Amakama soil and 17.55 and 0.45 mg/kg, respectively in Ajata-Ibeku soils. Both soils are deficient in macronutrients. Lead and Cd accumulation in turmeric followed the order: rhizome > root > shoot. Though over 50% of total Cd and Pb taken up by turmeric was transferred to the rhizomes, their presence did not pose any health risk to the consumers of turmeric spice as their computed provisional tolerable weekly intake (PTWI) values (< 0.25 mg Pb/person/week and 0.08 mg Cd/person/week) were far below recommended safe limits of 1.50 mg Pb/person/week and 0.42 mg Cd/person/week. Monitoring heavy metals in soils and edible plant parts should be regarded as a requirement for safe consumption of crops grown in contaminated agricultural fields. The need to conduct similar studies on other root and tuber crops was also highlighted.

Introduction
Hitherto, abandoned refuse dumpsites are usually invaded by peri-urban farmers for crop production. These sites are normally used for production of high-value-crops such as vegetables, ginger and turmeric. Farmers are attracted to those sites because of the high rate of returns on investment associated with crop production on such sites. The potential of heavy metals to accumulate in toxic concentrations at refuse dump sites have received wide attention. Alhough, Bushra *et al.* (2011) studied the heavy metal contamination of herbal drugs by environmental pollution, results showed that ginger (*Z. officinalis*), a close relation of turmeric (*C. longa*) contained toxic concentrations of Cd (1.63 μg/g) and Pb (13.13 – 22.63 μg/g). Similar research has not been carried out on the genus *Curcuma* to which turmeric belongs, and no known study has determined Pb and Cd uptake characteristics of turmeric plant. Turmeric (*Curcuma longa* Linn) is a tropical perennial herb. The rhizome of turmeric is used to make spice. Turmeric spice is a natural food colourant and preservative. It is the principal ingredient in curry powder. Turmeric's active ingredient is curcumin, which is found in the plant's rhizome, and is reputed to have a wide range of therapeutic effects. Turmeric is presently attracting a lot of interest because of the health benefits in the consumption of the rhizomes; however, people are expressing concerns over the high levels of Pb reported in turmeric processed spice (*http://www.nowfoods.com/M101512.htm assessed 9th June,2009*). Nevertheless, the report did not indicate the source of contamination. The absence of studies on Pb and Cd uptake by turmeric plant represents a gaping hole in vital scientific information considering that the crop is gaining acceptance in Nigeria as an herbal plant. The main objective of this investigation was to determine the effect of single and mixed Pb and Cd contaminations on the metals' uptake characteristics of turmeric.

Materials and Methods

Three sets of experiments were set up in the greenhouse at National Root Crops Research Institute, Umudike (Longitude 07° 33´E and Latitude 05° 29´N), each in a completely randomized design to study the effect of single Pb contaminations (0, 50, 10, 0, 150 and 200 mg/kg Pb), single Cd contaminations (0, 1.5, 3.0, 4.5 and 6.0 mg/kg Cd) and mixed Pb and Cd contaminations (0, 50 Pb + 1.5 Cd, 100 Pb + 3.0 Cd, 150 Pb + 4.5 Cd and 200 Pb + 6.0 Cd mg/kg) on metals' uptake characteristics of turmeric. All treatments were replicated three times. Five litres volume plastic pots were packed with 5 kg of soil and thereafter the potted soils were appropriately contaminated with lead nitrate [$Pb(NO_3)_2$] and cadmium chloride ($CdCl_2$), the inorganic sources of Pb and Cd respectively, according to the relevant treatment level. The soils were allowed to equilibrate for 3 days. Turmeric (*Curcuma longa* Linn) mother rhizome was planted in the potted soils. In order to eliminate nutrient deficiency, single fertilizers were added 8 weeks after planting (WAP) at the rates of 60 kg N, 13 kg P and 25 kg K/ha (Nwokocha *et al.,* 2009) using $(NH_4)_2SO_4$, $Ca_3(PO_4)_2$ and K_2SO_4 respectively. The plants were grown in the green house for a period of 20 WAP. The harvests (at 20 WAP) were separated into; shoots rhizomes and roots per plot. Samples were subsequently washed with deionized water and oven dried at 65°C to a constant weight. Dried samples were weighed to determine their dry matter yield. The samples were thereafter milled using a milling machine (THOMAS WILEY MILL model ED-5). The milled plant samples were oven-dried at 105°C for 2 hours. The plant samples were digested in a solution containing 3:1 HNO_3:$HClO_4$ solution. The samples were thereafter analyzed for Pb and Cd using Atomic Absorption Spectrometer (AAS) of UNICAM 919 model (Algeria *et al* (1991). Data obtained were subjected to statistical analysis of variance for a CRD experiment. Means were compared at 5% probability level using Duncan new multiple range test (DNMRT). Values of Pb and Cd in the rhizomes were compared with the WHO (1993) minimum allowable standards. All reagents used in the analysis were of analytical grade. Analysis was done in duplicate. In all determinations, blanks were included.

Results and Discussion

Background Soil Data

The two soils, Amakama (Fine-loamy, mixed, semi-active, isohyperthermic Rhodic Kandiudult) and Ajata-Ibeku (Fine, mixed, semi-active, isohyperthermic Aquic Haplustalf) soils (Chikezie *et al*., 2010) studied represent the most important agricultural soils of Abia State, southeastern Nigeria. Nonetheless, the background soil physicochemical properties (Table 1) showed that the soils have differing physicochemical properties, as a result of their contrasting parent materials. Amakama soil showed a sandy clay loam texture and Ajata-Ibeku soil a clayey texture. In Amakama soils, the values of ECEC (11.75 cmol/kg), pH (4.6), clay (22.6%) and OM (0.86%) were lower than corresponding values (ECEC (25.15 cmol/kg), pH (5.0), clay (56.3%) and OM (2.14%) obtained in Ajata-Ibeku soils. Background values of Pb and Cd were 26.30 and 1.05 mg/kg, respectively in Amakama soil and 17.55 and 0.45 mg/kg, respectively in Ajata-Ibeku soils. Both soils have acidic reaction and are deficient in macronutrients. Similar results were reported by Chikezie *et al.* (2010).

Uptake characteristics of Pb and Cd by turmeric plant

Concentrations of Cd and Pb in the organs of turmeric plant due to single and mixed Cd and Pb applications in the study soils are as presented in Table 2. Cadmium concentrations in *C. longa* L tissues were in the order of: rhizome > root > shoot in Amakama and Ajata-Ibeku single and mixed Cd treatments. However, amount of Cd accumulated in turmeric organs and whole plant varied with treatments and soil. High accumulation of Cd (≥ 50%) in the rhizome, out of the total accumulated Cd in the plant could be attributed to plant physiological processes and not to treatments applied in both soils, since they did not confer any significant ($P < 0.05$) difference in Cd accumulated in the rhizome (Table 2). Lasat *et al.* (1998) identified this as a plant mechanism responsible for immobilization. They explained that metals can be complexed and sequestered in cellular structures (e,g,, food vacuoles), becoming unavailable for translocation to the shoot. Their report may explain the amount of Pb and Cd accumulated in the rhizomes of turmeric relative to other plant parts. It is important to note that, out of the total amount of ions associated with the root (0.14 - 0.245 mg/kg), only a small part may have been absorbed into cells. According to Lasat (2000) a significant ion fraction is physically adsorbed at the extracellular negatively charged sites (COO^-) of the root cell walls in non-accumulators. The cell wall-bound fraction cannot be translocated to the shoots and, therefore, cannot be removed by harvesting shoot biomass (phytoextraction) (Lasat, 2000). In support of this, Blaylock and Huang (1999) concluded that the limiting step for most metal phytoextraction is the long-distance translocation from roots to shoots. In Amakama soils, co-presence of Pb and Cd caused a 21% increase in the rate of uptake of Cd levels in *C. longa* L above the uptake in single treatments and 23% in Ajata-Ibeku soils (Table 2). Miller *et al.* (1977) observed that the accumulation of Cd was increased by the addition of Pb in *Zea mays.* Similarly, Pb was observed to increase uptake of Cd in rye and Fescue (Carlson and Roffe, 1979). Lead concentrations in *C. longa* L tissues were in the order of: rhizome > root > shoot in Amakama single and mixed Pb treatments. However, in Ajata-Ibeku soil, Pb uptake was almost equally distributed in the organs (Table 2). A comparison of total Pb absorbed by *C. longa* L in the two study soils indicated that under single and mixed Pb treatments, *C. longa* L in Amakama soil absorbed higher Pb (1.623 mg/kg) under mixed Pb treatments, than it did under single Pb treatments (1.450 mg/kg). In Ajata-Ibeku soil, similar trend was not followed. Co-presence of Pb and Cd reduced Pb uptake by 9%. The differential Pb absorption under mixed treatments in the study soils may be due to differences in soil physicochemical properties which favoured Pb adsorption on soil particles in Ajata-Ibeku soils and less Pb being in solution for plant uptake. Results from this study showed that though over 50% of total Cd and Pb uptake by *C longa* L was transferred to the rhizome (Table 2), their presence in the rhizome did not pose any health risk as they were far below the recommended tolerable rhizome limits (10.7 mg Pb/kg d.w. and 3.0 mg Cd/kg d.w.) and having Provisional Tolerable Weekly Intake (PTWI) values (< 0.25 mg Pb/person/week and < 0.08 mg Cd/person/week, against WHO (1993) PTWI standards of 1.50 mg Pb/person/week and 0.42 mg Cd/person/week) were under safe limits. A daily intake of turmeric rhizome of 20 g was assumed to be consumed by an average body weight of 60 kg and was used to calculate the PTWI values used in this study.

Conclusion

Though over 50% of total Cd and Pb taken up by turmeric was transferred to the rhizomes, their presence did not pose any health risk to consumers of turmeric spice as their computed provisional tolerable weekly intake (PTWI) values (< 0.25 mg Pb/person/week and 0.08 mg Cd/person/week) were far below WHO (1993) safe limits of 1.50 mg Pb/person/week and 0.42 mg Cd/person/week. There is scope to carry out similar research on Pb and Cd uptakes in other root and tuber crops and in other soil types since they have not been studied locally. A study in which accumulation of Pb and Cd in animal organs are investigated and related to their levels in root and tuber crops and soils would assist policy makers to draw up management practices and policies on risk assessment of Pb and Cd in the country.

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Table 1: Physico-chemical properties of the study soils at 0 – 30 cm depth

Soil property	Amakama soil	Ajata-Ibeku soil
Sand (%)	74.1	23.3
Silt (%)	3.3	20.5
Clay (%)	22.6	56.3
Texture*	SCL	C
pH (H_2O)	4.6	5.0
Total nitrogen (%)	0.087	0.269
Avail. phosphorus (mg/kg)	45.9	5.6
Organic matter (%)	0.86	2.14
ECEC (cmol/kg)	11.75	25.15
Base Saturation (%)	14.5	28.4
Pb (mg/kg)	26.30	17.55
Cd (mg/kg)	1.05	0.45

*Texture: SCL = Sandy clay loam; C = Clay; ECEC = Exchangeable Cation Exchange Capacity.

Table 2: Uptake of Cd and Pb by turmeric organs as influenced by single and mixed Cd and Pb treatments

Treatment	Metal uptake (mg/kg)							
	Root	Rhizome	shoot	Total uptake	Root	Rhizome	shoot	Total uptake
	Amakama soil				Ajata-Ibeku soil			
Cd single treatment (mg/kg)								
Control	0.040 ^{a}	0.066 ^{a}	0.012 ^{a}	0.119 ^{a}	0.014 ^{a}	0.181 ^{a}	0.083 ^{cb}	0.278 ^{a}
Cd 1.5	0.078 ^{b}	0.082 ^{a}	0.044 ^{a}	0.205 ^{ba}	0.096 ^{ba}	0.197 ^{a}	0.051 ^{a}	0.345 ^{a}
Cd 3.0	0.137 ^{d}	0.175 ^{a}	0.018 ^{a}	0.330 ^{cba}	0.106 ^{b}	0.236 ^{a}	0.066 ^{ba}	0.408 ^{a}
Cd 4.5	0.105 ^{cb}	0.235 ^{a}	0.124 ^{a}	0.464 ^{cb}	0.138 ^{b}	0.193 ^{a}	0.097 ^{c}	0.428 ^{a}
Cd 6.0	0.112 ^{dc}	0.339 ^{a}	0.105 ^{a}	0.556 ^{c}	0.245 ^{c}	0.212 ^{a}	0.097 ^{c}	0.553 ^{a}
Organ mean	**0.094**	**0.179**	**0.061**	**0.334**	**0.120**	**0.204**	**0.079**	**0.402**
Cd mixed treatment (mg/kg)								
Control	0.040 ^{a}	0.066 ^{a}	0.012 ^{a}	0.119 ^{a}	0.014 ^{a}	0.181 ^{a}	0.083 ^{a}	0.278 ^{a}
Cd 1.5 + Pb 50	0.061 ^{a}	0.122 ^{a}	0.012 ^{a}	0.195 ^{a}	0.111 ^{b}	0.215 ^{a}	0.079 ^{a}	0.405 ^{a}
Cd 3.0 + Pb 100	0.110 ^{b}	0.181 ^{a}	0.029 ^{a}	0.320 ^{ba}	0.207 ^{c}	0.491 ^{a}	0.089 ^{a}	0.787 ^{a}
Cd 4.5 + Pb 150	0.139 ^{b}	0.384 ^{a}	0.132 ^{a}	0.655 ^{cb}	0.157 ^{cb}	0.225 ^{a}	0.087 ^{a}	0.469 ^{a}
Cd 6.0 + Pb 200	0.198 ^{c}	0.424 ^{a}	0.201 ^{a}	0.822 ^{c}	0.152 ^{cb}	0.369 ^{a}	0.155 ^{b}	0.676 ^{a}
Organ mean	**0.110**	**0.235**	**0.077**	**0.422**	**0.128**	**0.296**	**0.099**	**0.523**
Pb single treatment (mg/kg)								
Control	0.091 ^{a}	0.139 ^{a}	0.034 ^{a}	0.264 ^{a}	0.114 ^{a}	0.060 ^{a}	0.180 ^{a}	0.354 ^{a}
Pb 50	0.435 ^{b}	0.816 ^{a}	0.214 ^{a}	1.464 ^{cb}	0.222 ^{ba}	0.385 ^{c}	0.368 ^{b}	0.975 ^{b}
Pb 100	0.403 ^{b}	0.981 ^{a}	0.578 ^{a}	1.962 ^{cb}	0.471 ^{b}	0.495 ^{d}	0.393 ^{b}	1.359 ^{c}
Pb 150	1.266 ^{c}	0.937 ^{a}	0.090 ^{a}	2.292 ^{c}	0.471 ^{b}	0.532 ^{d}	0.231 ^{a}	1.233 ^{cb}
Pb 200	0.119 ^{a}	0.899 ^{a}	0.250 ^{a}	1.269 ^{b}	1.039 ^{a}	0.289 ^{b}	0.747 ^{c}	2.076 ^{d}
Organ mean	**0.463**	**0.754**	**0.233**	**1.450**	**0.463**	**0.352**	**0.384**	**1.199**
Pb mixed treatment (mg/kg)								
Control	0.034 ^{a}	0.139 ^{a}	0.091 ^{a}	0.264 ^{a}	0.114 ^{a}	0.060 ^{a}	0.180 ^{a}	0.354 ^{a}
Pb 50 + Cd 1.5	0.153 ^{a}	0.325 ^{a}	0.156 ^{b}	0.634 ^{a}	0.133 ^{a}	0.238 ^{ba}	0.235 ^{ba}	0.606 ^{a}
Pb 100 + Cd 3.0	0.218 ^{a}	0.565 ^{ba}	0.332 ^{c}	1.115 ^{a}	0.571 ^{cb}	0.324 ^{cb}	0.259 ^{b}	1.154 ^{b}
Pb 150 + Cd 4.5	0.942 ^{b}	1.506 ^{b}	0.350 ^{c}	2.799 ^{b}	0.682 ^{c}	0.452 ^{c}	0.243 ^{ba}	1.378 ^{b}
Pb 200 + Cd 6.0	0.703 ^{ba}	1.730 ^{b}	0.870 ^{d}	3.303 ^{b}	0.432 ^{b}	0.798 ^{d}	0.747 ^{c}	1.977 ^{c}
Organ mean	**0.410**	**0.853**	**0.360**	**1.623**	**0.386**	**0.374**	**0.333**	**1.094**

Columns with different superscripts are significantly different at $P < 0.05$ (DNMRT).

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Strategies for Disseminating Biochar among Small Holder Farmers

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Abstract
Biochar is the by-product obtained when biomass is burned or heated with a minimum or absence of oxygen. Research consistently reveals that poor soils enriched with biochar grow bigger and stronger plants that yield higher crop quantity and quality. Organic agricultural wastes are annually available on small holder farms in abundance in developing countries. These agricultural wastes are of low monetary value and can cause environmental pollution. These agricultural by products could be a principal source for value added products for use in improving agricultural soil condition for enhanced crop productivity and disease suppression. Using crop residues for the developments of biochar products (such as: Biochar bokashi, glomali, biochar compost and other blends) for agricultural applications could provide an additional source of revenue for small holders farmers; while at the same time, reducing environmental pollution, mitigating climate change and improving the aesthetic value of small farms. Determining where and how to apply biochar begins with the characterization of the biochar material. Characteristics of biochar materials will vary depending on what the biochar is made from, and how it is made. When applying biochar to soil for improving its fertility, the biochar should ideally be located near the soil‟s surface in the root zone, where the bulk of nutrient cycling and uptake by plants takes place. Certain systems may benefit from the application of biochar in layers below the root zone, for example during landscaping for C sequestration or if using biochar for moisture management. When deciding how to apply biochar to soil, the specific cropping system must be taken into consideration.

Introduction
Biochar is a fine-grained, highly porous biological charcoal substance that is distinguished from other charcoals in its intended use as a soil amendment. Biochar is charcoal that has been produced under conditions that optimize certain characteristics deemed useful in agriculture, such as high surface area per unit of volume and low amounts of residual resins, Nkongolo et.al. (2002), Ekebafe (2011). Biochar is a fine-grained charcoal high in organic carbon and largely resistant to decomposition. It is produced from pyrolysis of plant and waste feedstocks. As a soil amendment, biochar creates a recalcitrant soil carbon pool that is carbon-negative, serving as a net withdrawal of atmospheric carbon dioxide stored in highly recalcitrant soil carbon stocks. The enhanced nutrient retention capacity of biochar-amended soil not only reduces the total fertilizer requirements but also the climate and environmental impact of croplands Ekebafe et., al. (2011). Char-amended soils have shown 50 - 80 percent reductions in nitrous oxide emissions and reduced runoff of phosphorus into surface waters and leaching of nitrogen into groundwater. The heat treatment of organic biomass used to produce biochar contributes to its large surface area and its characteristic ability to persist in soils with very little biological decay, Lehmann et.al (2006). While raw organic materials supply nutrients to plants and soil microorganisms, biochar serves as a catalyst or a conditioner that enhances plant uptake of nutrients and water. Compared to other soil amendments, the high surface area and porosity of biochar enable it to adsorb or retain nutrients and water and also provide a habitat for beneficial microorganisms to flourish, Lehmann et.al (2006), Glaser (2007), Warnock et.al (2007). The production and application of biochar over the years by small holder farmers has been a challenge because of the lack of simple and cost effective technology and technique to effectively harness the benefits of these materials to soil.

Available data shows that current use of biochar is on a mechanized scale. There is need therefore to create a bridge between the small holder farms and the mechanized in the subject matter. Hence the need for the study with the specific objective of unveiling the technology and technique that could be used by small holder farmers for the production and application of biochar to soils.

Biochar Production

Biochar is produced after pyrolysis of biomass, typically within a temperature range of 200°C to 700°C. Pyrolysis is the thermal degradation of biomass under the (partial) absence of oxygen. Pyrolysis results in three products: biochar, non-condensable gases and condensate (tars and water). The proportion of each is a strong function of the feedstock and the operating conditions of the pyrolyser, Ekebafe et., al. (2013ab). As such, the design of the pyrolysis kiln or retort is important in determining temperature range and biomass to biochar conversion efficiency Reddy, (2014). For small holder farmers particularly in the rural areas where biochar is simply the end-product left behind after meals have been prepared on biomass stoves; stove design determines the rate of energy generated, biochar and ash produced as by products. With its higher efficiency, a typical „good stove" reduces biomass fuel consumption and produces 20% to 60% biochar of the original biomass used as fuel by weight, Reddy (2014), Antal and Gronli (2003). However, there are other methods of producing biochar which include: trench mould kilns, mould kiln, pit kiln, biochar kiln, magh biochar retort, and the Geo mini metal retort. In all, the small holder farmers can produce high quality biochar using the traditional biochar stove, biochar kiln, pit kiln and the traditional moulds. The typical rural charcoal burning mound is about 4 m in diameter at the base and about 1 m to 1.5 m high, looking somewhat like a flattened hemisphere. Six to ten air inlets are made at the base, with an opening at the top of about 20cm in diameter to allow smoke to exit during the burning. All openings must be sealed with earth when burning is complete and the mound should be allowed to cool as shown in Figure 1. Biochar pit kiln is one of the simplest methods of converting crop residue and other biomass into biochar. Farmers can easily create pits or trenches and convert the biomass residue. As shown in Figure 2. About 60% biochar production is possible with biochar kiln technology (Figure 3). Three to four hours are required to produce a batch of charcoal. These kiln are highly suitable for making biochar. Many small holder farmers can generate biochar from the following sources: Campfires with chunks of charcoal remaining after fires. Wood burning stoves may be operated in such a way as to produce a small amount of charcoal. In most regions, it is possible to purchase "lump wood charcoal" for grilling food. Charcoal "briquettes" and Spent charcoal from an aquarium filter.

Figure1: Charcoal being produced by traditional earth mound kiln method

Figure2: Biochar being produced by pit kiln method

Figure 3: Locally produced Biochar kiln

Characterization and Testing of Biochar

Determining where and how to apply biochar starts with the characterization of the biochar material. Characteristics of biochar materials will vary depending on what the biochar is made from, and how it is made (That is the feedstock and the technology). Change in the pH, ash content, surface area, and other characteristics of biochar is the basis for the concept of designer biochar, Novak et., al., (2009), where the characteristics of a biochar are matched to the specific needs of a soil and/or soil management system. For example, certain high-pH biochars may be best for applying to acidic soils, while others with elevated contents of highly recalcitrant C (but which are amorphous in structure) might be better suited to situations where C sequestration is the main goal, Blackwell et., al. (2009). Before adding biochar or any amendment to field soil, one should ensure it will not be harmful in that environment at the intended application rate. Biochar made under certain conditions may contain substances that are harmful to plants, and the suitability for soil application may therefore be in doubt. It is therefore necessary to determine the suitability of a biochar for soil application by carrying out the tests below, designed to assess the presence of harmful substances. These tests are also described in IBI Technical Bulletin 101, Julien Major (2010), they include the germination test, the worm avoidance test and the field test. The goal of germination tests is to determine whether adding biochar to soil has an effect on seed germination. It is assumed that a negative effect indicates the presence of undesirable compounds in the biochar material. Lettuce (Lactuca sativa L.) is the most widely recommended species to use, due to its sensitivity to the presence of toxins and contaminants in general (US EPA 1994). Other species that could be used include radish (Raphanus L.) and clover (Trifolium L.). The worm test is more complex test, since it requires live worms to complete. However, it may be more sensitive than a germination test with plant seeds. A common type of worm used for this test is the white worm (Enchytraeus albidus). Alternatively, worm species Eisenia fetida and Eisenia andrei, commonly known as redworms, brandling worms, tiger worms and red wiggler can be used. In the field test, two concepts should be kept in mind when doing field trials: 1) biochar amended soil needs to be compared to an appropriate alternative treatment, the "control"; and 2) it is best to replicate your treatments by planting multiple plots of the biochar amended and control treatments across the field. Testing biochar in more than one location is desirable because there is a chance that the location which was chosen for the biochar is different from the location where the control is applied, and this can affect the results either positively or negatively.

Soil Application of Biochar

The particle size of biochar affects its mode of application. With small particles, it is important to apply biochar in ways that minimize loss due to wind or water erosion. A best management practice to greatly reduce such wind losses is to moisten biochar, however adding water increases the weight of the material and this can increase transport costs. While water is usually added to biochar immediately after exiting the pyrolysis unit in order to quench it, more water could be applied to reduce dustiness prior to field application Ekebafe et., al. (2015), Blackwell et., al. (2007). Moisture content must always be taken into consideration when determining application rate, whether or not the end user adds water themselves. Biochar that is seemingly dry can contain a high percentage of moisture, and application rates can be overestimated. It is helpful to apply biochar during mild rain conditions where light rain will dampen biochar dust and hold it on the soil surface until it can be tilled in. The application rate of Biochar materials are greatly influenced by their characteristics, thus the nature of a specific biochar material (e.g. pH, ash content) also influences application rate. In the published literature, several studies have reported positive effects of biochar application on crop yields with rates of 5-50 tonnes of biochar per hectare, with appropriate nutrient management. This is a large range, but often when several rates are used, the plots with the higher biochar application rate show better results (Chan et al., 2007, 2008; Major et al., 2010). Since the C content of biochar materials varies, it may be appropriate to report application rates in tonnes of biochar-C per hectare, as opposed to tonnes of bulk biochar material. A 10 t/ha application of poultry manure biochar contains much less C (and more ash) than an equivalent application of wood waste biochar. However, ―high-ash biochar can constitute a source of various plant nutrients, and these should be taken into consideration when managing soil fertility at the field level. Due to its recalcitrance to decomposition in soil, single applications of biochar can provide beneficial effects over several growing seasons in the field (Steiner et al., 2007; Major et al., 2010). Most biochar materials are not substitutes for fertilizer, so adding biochar without necessary amounts of nitrogen (N) and other nutrients cannot be expected to provide improvements to crop yield. Since biochar itself cannot be considered a source of nutrients (unless it has a high ash content), there is interest in blending it with other materials such as synthetic fertilizers, compost, composites and manures to enhance its value as a soil amendment. Furthermore, biochar has been shown to retain nutrients against leaching (Major et al., 2009; Novak et al., 2009), potentially improving the efficiency of nutrients applied alongside biochar. Adding biochar to sewage sludge or poultry manure during composting has been shown to reduce N losses (Dias et al., 2009; Hua et al., 2009) and the mobility of some heavy metals was also reduced in sewage sludge compost with biochar (Hua et al., 2009). Dias et al. (2009) compared biochar to other bulking agents for compost making, and found that adding biochar resulted in greater humification or —maturity of the compost at the end of the study period. It is also believed that adding biochar to composts and manures can reduce odour. When applying biochar to soil for improving its fertility, the biochar should ideally be located near the soil‟s surface in the root zone, where the bulk of nutrient cycling and uptake by plants takes place, Ekebafe (2011). Certain systems may benefit from the application of biochar in layers below the root zone, for example during landscaping for C sequestration or if using biochar for moisture management. Similarly, if biochar were to be applied to soil solely for C sequestration purposes, placement deeper in the soil, for example in new landscaping or construction areas, would be desired since microbial activity that can degrade biochar carbon is reduced deeper in the soil profile. When deciding how to apply biochar to soil, the specific cropping system must be taken into consideration. The likelihood of wind and water erosion losses of biochar is reduced when biochar is thoroughly incorporated into soil, however, plowing and soil mixing are not possible or desirable in all cropping systems, at all times, Julien Major (2010).

Conclusion

Biochar production and application in small holder farms may create a triple wins scenario, where farmers get higher yields and compensation for environmental services; society gets reduced eutrophication and less negative environmental impacts from intense farming practices; and humanity gets sustainable food production at the same time as climate change effects and the connected risk of reaching climate tipping points are reduced. Biochar contribute to a sustainable society in its true meaning for future generations by closing the cycles between arable land and human habitations. The technique is democratic, since it can be applied anywhere around the globe where plants are growing and it is not dependent of economic, technical or infrastructural development. It is independent of scale, too, so also home gardeners and small holder farmers may transform garden waste into a soil improver to use in their own garden or farms.

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The Effect of three Agroforestry Species of Varying Age Series on the Physical and Chemical Properties of an Alfisol in Ibadan,Oyo State, Nigeria

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Abstract
A study was conducted at the agroforestry plantation of the Forestry Research Institute Nigeria, Ibadan (latitudes 7°N to 7.2°N and longitudes 26°E to 27°E) in year 2016 to evaluate the effects of tree species, age and soil depth on soil physical and chemical properties. The experiment was a 3×3×2 factorial arrangement in Randomised Complete Block Design with three replications comprising of three tree species (Tectona grandis, Gmelina arborea and Terminalia superba), three tree age intervals (5-10yrs, 10-15yrs and 15-25yrs), and two soil depths (0-15 cm and 15-30 cm). Soil properties determined included pH, particle size distribution, available P, total N, organic carbon, exchangeable cations, effective CEC and micronutrients and data collected were subjected to Analysis of Variance and means were separated using Duncan's Multiple Range Test at p<0.05. Results showed that 15-25 years old Gmelina arborea had soils with the greatest clay content (29.1 g/kg) while 5-10 years old Terminalia superba had the least clay content (6.90g/kg). Soils of Terminalia of all the age groups tend to have the highest silt content(86.0 g/kg). Soil pH was moderately acidic (5.88) and did not vary significantly (p<0.05) under the tree species, age group and soil depth. The interaction effect of tree species and age showed significant difference in soil organic carbon. Terminalia at 5-10 years old and Gmelina at 15-25 years old had the highest soil organic carbon content (27.5 g/kg) while Terminalia at 15-25 years old had the least soil organic carbon content (15.3 g/kg).The study concluded that agroforestry tree species and tree age had varying effects on soil chemical and physical properties.
Keywords: Agroforestry, Tectona grandis, Gmelina arborea, Terminalia superba, physical and chemical properties.

Introduction
Agroforestry is a collective name for land use system and practices where woody perennials are deliberately integrated with crops and / or animals in some form of spatial arrangement or temporal sequence (ICRAF, 2000). The role of agroforestry to agricultural sustainability is very significant. It provides opportunities to balance productivity and profitability with environmental stewardship and pass on healthy and sustainable agricultural systems to future generation (Adekunle, 2009). Agroforestry is a scientific approach for eco- restoration of degraded lands and sustainable resource management. Several factors have contributed to a rising interest in agroforestry since the 1970, the deteriorating economic situation in many parts of the world, increased tropical deforestation, degradation and scarcity of land because of population pressures and growing interest in farming systems, intercropping and the environment (Adekunle, 2009). Agroforestry practices encompass an entire spectrum of land use systems in which woody perennials are deliberately combined with agricultural crops / or animals in some spatial or temporal arrangement (lundgren and Raintree 1982). The presence of woody perennials in agroforestry systems may affect biophysical and biochemical processes that determine the health substrate (Nair *et al*., 1995). The effects of trees on soil may include; amelioration of erosion, primarily through surface litter cover and under storey vegetation maintenance or increase of

organic matter and diversity, through plant root and decomposition of litter, nitrogen fixation, enhancement of physical properties such as soil structure, porosity and moisture retention due to the extensive root system and the canopy cover, and enhanced efficiency of nutrient use because the tree- root system can intercept and recycled nutrients in the soil that would have been lost through leaching. Nigeria is blessed with a large area of land and vegetation, but the use of this important resource has been abused, not sustainably used or managed. Recently everyone now realise that forest is at the verge of going to extinction if nothing is done to reverse the unsustainable use. Jama(2000) reported that Nigeria is witnessing the depletion of reserves due to hunger for more land for food production in agriculture, shifting cultivation as well as urbanization. Agriculture, Forestry and Urban development, remained the three major uses to which land is subjected. These various uses to which land is subjected have resulted in environmental stress and degradation, which has consequently led to the reduction of land area available for farming. Hence farmers have been restricted to consisted farming on the same land area for a long time, which has often resulted into decline in crop yield as well as environmental degradation. It has been hypothesized that, under agroforestry systems, soil organic carbon can be maintained at levels that are satisfactory for soil fertility due to the contribution of decomposed residues from the tree component. The contribution may come from above-ground litters and pruning, root residues, or indirectly as farmyard manure where pruning are fed to livestock. The presence of trees in a crop field influences soil structures via two main phenomena.Firstly, according to (Seiters *et al*, 1999) the trees bring organic matter to the soil through litter fall, stwigs, root turn over, pruning bye product, and an important increased was been observed in alley cropping systems planted with red alders (Seiter *et al*, 1999). Secondly, the trees develop important roots system that explore and improve notably deep and compacted soil layers that crop roots do not reach. These two phenomena have seven major effects on soil structure. By increasing the cover of the soil, the presence of the trees limits the effects of wind and rain erosion. The increase of organic and the development of root system limit soil compaction, improves water infiltration (Chander *et.al*, 1998) and increases basan soil respiration (Chander *et. al*, 1998). Moreover, they increase the weight of soil aggregates and so increase soil stability and decrease erosion risk in response to rainfall (Gupta *et.al*, 2009). The above effect can be beneficial for crops because the root ability to permeate the soil and plant capacity to uptake and export water and nutrients from the soil is improved.

Materials and Methods

Experimental site

The study site is at the agroforestry plantation of the Forestry Research Institute of Nigeria (FRIN) Ibadan, Oyo state, Nigeria (Figure 1). The area is between Latitude 7°N to 7.2°N and Longitude 26°E to 27°E. The climate is mainly tropical with rainfall patterns ranging between 1,000 mm and 14,500mm, the average temperature is about 30°C while relative humidity is about 65%.

Experimental Design

The experiment was a 3 x 3 x 2 factorial in Randomised Complete Block Design with three replications (3 agroforestry species, 3 Age series, and 2 soil depths). The 3 agroforestry species include; *Gmelina arborea, Terminalia superba,* and *Tectona grandis*. The three age series include: 5-10 years, 10-15years, 15-25years, and the two depths were 0-15 cm and 15-30 cm soil depth.

Soil sample collection and preparation

Soil samples were collected from 0-15 cm and 15-30 cm depth using auger (plate 1,2 and 3) and the coordinate of each sampling point were determined with the aid of geographical positioning system (GPS). The bulk samples were then air dried and passed through 2 mm sieve to remove rock and un-decompose organic material.

Result and Discussion

Table 1 show that the effect of agroforestry tree species, tree age and soil depth was only significant on the clay content of the soil (Table 1). *Gmelina* had significantly greater clay content than soils under *Terminalia* and *Tectona*. The age group 15-25 years had the highest clay content. The subsoil had greater clay content. The interaction between tree species and tree age was significant on the clay and silt contents of the soil though other possible interaction effects were not significant. *Gmelina* 15-25 years old had soils with the greatest clay content while *Terminalia* 5-10 years old had the least clay content (Table 2). *Terminalia* at all the age groups tend to have the highest silt content. The soil pH was moderately acidic and did not vary significantly under the tree species, age group and soil depth. There was no significant interaction between tree species and age group, tree and soil depth, and tree, age and soil depth on the medium of soil reaction. The total nitrogen, exchangeable sodium, potassium, magnesium and the micronutrients (Mn, Fe, Cu and Zn) all followed the same trends as the soil pH. The soil organic carbon was high but did not vary significantly under the agroforestry tree species. The age of the trees had significant effect on the organic carbon. Trees of 15-25 years had greater soil organic carbon. Depth wisely, there was no variation in the soil organic carbon of the surface and subsurface. The interaction between tree species and age showed significant effect on soil organic carbon. *Terminalia* at 5-10 years old and Gmelina at 15-25 years old had the highest soil organic carbon content while *Terminalia* at 15-25 years old had the least soil organic carbon content though not significantly different from those of *Tectona* at 5-10 and 10-15 years old. Exchangeable calcium varied significantly from 5.28 – 1.61 cmol kg-1 under the *Gmelina* and *Terminalia*, respectively. The effect of tree age was also significant, trees of 15-25 years old had greater soil exchangeable calcium than others. The main effect of soil depth and all the interactions were not significant at 5 % probability level

Table 1: Effect of different Agro-forestry tree species, Tree ages and Soil depth on Physical and Chemical properties of soils

Factors		PH (H_20)	O.C (%)	TN (%)	Particle size (%)			Exch. bases (cmol/kg)				Micronutrient (mg/kg)			
					Sand	Clay	Silt	Na	K	Ca	Mg	Mn	Fe	Cu	Zn
TREES	TS	5.88	2.00a	0.21	75.7	0.77b	8.17	14.5	2.32	1.61c	11.44	83.4	78.3a	2.37	2.37
	TG	5.80	2.03a	0.17	76.6	0.87b	8.35	14.9	1.31	3.04b	11.00	78.4	113.9a	2.44	2.44
	GA	5.81	2.11a	0.42	72.9	2.91a	7.67	20.4	2.15	5.28a	11.13	110.5	86.8a	2.84	2.84
AGE	A	5.82	2.02b	0.17	74.5	0.69b	9.12	14.1	1.64	3.45b	10.74	72.5	69.3b	2.43	2.43
	B	5.78	1.79b	0.15	76.6	0.94b	8.53a	15.7	2.02	2.92b	10.95	101.2	107.6a	2.53	2.53
	C	5.90	2.34a	0.47	74.1	2.90a	6.55	19.9	2.11	3.55a	11.88	98.6	102.2a	2.68	2.68
Depth	TOPS	5.86	2.12a	0.33	75.2	0.72b	8.31	17.6	1.68	3.22a	10.77	87.6	89.5a	2.55	2.55
	SUBS	5.80	1.98a	0.20	75.0	2.30a	7.82	15.6	2.17	3.39a	11.61	93.91	96.6a	2.55	2.55
DMRT ($P \leq 0.05$)															
Trees x Age		0.23	0.48	NS	NS	3.37	2.57	NS	NS	NS	NS	NS	NS	NS	NS
Trees x Depth		NS	NS	NS	NS	NS	NS	NS	NS	NS	2.51	NS	NS	NS	NS
Age x Depth		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Trees x Age x Depth		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by same letters are not significantly different from each other at P>0.05
Tree: TS =*Terminalia superba*, TG= *Tectona grandis,* GA= *Gmelina arborea*
Age: A =5-10 years, B= 10-15 years, C= 15-25 years

Table 2: Interaction between Tree species and Age intervals on physical and chemical properties of soil under agroforestry trees

Trees	Age	PH (H_20)	O.C (%)	Clay	Silt
TS	5-10	6.06a	2.54a	0.42b	7.47ab
	10-15	5.86ab	1.97b	1.20b	8.45a
	15-25	5.74bc	1.53b	0.68b	8.60a
TG	5-10	5.49c	1.67b	0.83b	9.70a
	10-15	5.91ab	1.68b	0.86b	9.85a
	15-25	5.99ab	2.75a	0.91b	5.50b
GA	5-10	5.90ab	1.86b	0.83b	10.18a
	10-15	5.58c	1.74b	0.76b	7.28ab
	15-25	5.95ab	2.75a	7.12a	5.55b

Tree: TS =*Terminalia superba*, TG= *Tectona grandis,* GA= *Gmelina arborea*
Means followed by same letter are not significantly different (P>o.o5)

Conclusion

The effects of agroforestry tree species and tree age on soil physical and chemical properties were evaluated. It could be concluded that agroforestry tree species and their age have varying effects on soil physical and chemical properties. *Gmelina* of 15-25 years old had soils with the greatest clay content while *Terminalia* of 5-10 years old had the least clay content. The effect of tree age was also significant; trees with 15-25 years old had high soil exchangeable calcium among others.

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The Phospsorus Fractions of an Alfisol under Different Agroforestry Species

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Abstract
Understanding phosphorus (P) dynamics in soil in relation to plant nutrition is essential for optimizing P management and improving P-use efficiency as well as recycling P from plant litters. A study was conducted at the agroforestry plantation of the Forestry Research Institute Nigeria, Ibadan (latitudes 7°N to 7.2°N and longitudes 26°E to 27°E) in year 2016 to evaluate the effects of tree species, age and soil depth on P fractions and as well as the interrelationships between these and other soil properties. The experiment was a 3×3×2 factorial arrangement in Randomised Complete Block Design with three replications comprising of three tree species (Tectona grandis, Gmelina arborea and Terminalia superba), three tree age intervals (5-10yrs, 10-15yrs and 15-25yrs), and two soil depths (0-15 cm and 15-30 cm). Soil properties determined included pH, particle size distribution, available P, total N, organic carbon, exchangeable cations, effective CEC and micronutrients. Phosphorus fractions determined included labile P (Lab-P), Al and Fe- P (Al/Fe-P), Ca bound P (Ca-P), residual P (Res-P) and organic P (Org-P). Data collected were subjected to Analysis of Variance and means were separated using Duncan's Multiple Range Test at p<0.05. Results showed that the soil pH was moderately acidic (5.88±1.20) and did not vary significantly (p<0.05) under the tree species, age group and soil depth. Tree species and tree age, tree species and soil depth, tree age and soil depth, tree, age and depth interactions did not have significant impact on the available, labile, Al/Fe and Ca-P. There was significant interaction effect (p<0.05) between tree age and soil depth on the residual and Org-P. In all, the soils under the various agroforestry tree species, Org-P, followed by the available P were the most abundant P fractions and the least was Ca-P fraction. The specific phosphorus requirement increased with increasing tree age and Lab-P (p<0.05) negatively correlated (r = -0.6150) with Res-P, Org-P and sand content, while it positively correlated (r = 0.029) with the soil potassium content. The study concluded that agroforestry tree species and tree age had varying effects on soil chemical and physical properties and phosphorus fractions . These factors should therefore be taken into consideration in soil phosphorus management programmes.*

Keywords: Phosphorus fractions, Tectona grandis, Gmelina arborea, Terminalia superba, Agroforestry

Introduction
Phosphorus (P) is a critical macronutrient for plant growth that acts in various basic cellular functions (such as biosynthesis of adenosine triphosphate—ATP), in the activation of metabolic intermediates, as a component in signal transduction cascades and post-translational regulation of enzymes, and as a structural element in nucleic acid and phospholipids (Crews and Brookes, 2014). However, plant growth is limited due to poor availability and low mobility of P in the soil. Thus, P deficiency presents a significant global concern to crop production (Sharma *et al*. 2013). Although most soils in the world contain a significant amount of P, around 200—3,000 mg P per kg of soil (Richardson et al. 2009), only a small proportion of this (generally less than 1 %) is immediately available to plants due to its physicochemical behaviour and interaction with the soil mineral interface (Stewart and Tiessen 1987). In highly weathered soils, such as the tropical Oxisols, P deficiency is mainly attributed to the strong adsorption of phosphate by Al- and Fe-

oxides through a mechanism not completely elucidated (Grafe, 2000). Notwithstanding, plants possess a number of physiological adaptations that enhance P acquisition under conditions of low P availability. These included strategies that preserve internal P or those that increase the availability of P through the modification in root structure or function (Richardson *et al*. 2009) or even making a symbiotic association with specific microorganisms such as mycorrhizae (Xavier, 2011). The interrelations among the various forms of P within soil are complex. However, information about the distribution of soil P pools can increase our understanding about sinks and sources of P in the soil, and is essential for an efficient P management programme (Haygarth *et al*. 2014). Soil P transformations are primarily mediated by microbial activity, which is influenced by a combination of factors that can affect the P dynamics in the soil, including plant species, environmental conditions, soil type and soil management (Xavier, 2011). The challenge for cultivation of soils with low P availability, such as Oxisols, is to develop strategies of management that can enhance P acquisition by plants, for instance favouring the build-up of organic P pool. One of these important strategies is intercropping with tree species as in agroforestry systems (Gordon *et al*. 2016). Agroforestry systems have been pointed out as a major opportunity to reclaim degraded agricultural lands in the Rainforest biome (Grafe, 2000). Agroforestry systems can enhance nutrient-use efficiency in tropical soils, including P, by increasing the cycling of nutrients from tree litter and prunings; and reducing losses by erosion (Atangana *et al*., 2014). The forms of P in soils and sediments can be operationally defined by chemical extraction schemes (Adhikari *et al*., 2015). Briefly, they assumed that the major inorganic P components are: (1) adsorbed by exchange sites; (2) associated to complexes of Fe- and Al-oxides; (3) associated with calcium or carbonates; or (4) stabilized in a crystalline mineral. The organic P fraction in turn can be associated with: (1) labile organic matter; (2) humic substances; (3) acid-soluble organic components; or (4) residual or refractory phosphate esters and phosphonates (Hedley *et al*. 1982). The estimation of the various P pools in the soil is usually carried out by sequential P fractionation, which includes the use of increasingly aggressive reagents. One of the fractionation procedures often used is that of Hedley (Hedley *et al*. 1982) further modified by Tiessen and Moir (1993). The later comprises the sequential extraction of inorganic and organic P forms by using reagents with different strength of extraction, resulting in the fragmentation of soil P, taking into account their different degree of lability. H_2O–Pi and $NaHCO_3$–Pi and –Po are considered the most labile P pool; NaOH–Pi and –Po and diluted HCl–Pi as moderately labile P; whereas hot concentrated HCl–Pi and –Po and residual-P as non-labile P pool (Tiessen and Moir 1993)

Materials and Methods

Experimental site

The study site is at the agroforestry plantation of the Forestry Research Institute of Nigeria (FRIN) Ibadan, Oyo state, Nigeria (Figure 1). The area is between Latitude 7°N to 7.2°N and Longitude 26°E to 27°E. The climate is mainly tropical with rainfall patterns ranging between 1,000 mm and 14,500mm, the average temperature is about 30°C while relative humidity is about 65%.

Experimental Design

The experiment was a 3 x 3 x 2 factorial in Randomised Complete Block Design with three replications (3 agroforestry species, 3 Age series, 2 soil depth). The 3 agroforestry species include; *Gmelina arborea, Terminalia superba,* and *Tectona grandis*. The three age series include: 5-10 years, 10-15years, 15-25years, and the two depths were 0-15 cm and 15-30 cm soil depth.

Soil sample collection and preparation

Soil samples were collected from 0-15 cm and 15-30 cm depth using auger (plate 1,2 and 3) and the coordinate of each sampling point were determined with the aid of geographical positioning system (GPS). The bulk samples were then air dried and passed through 2 mm sieve to remove rock and un-decompose organic material.

Results and Discussion

Table 1 shows the The distributions of soil phosphorus fractions as affected by agroforestry species.The effect of different agroforestry tree specie and their age showed significance on the various fractions of soil phosphorus (Table 3). Soils under *Terminalia* had the highest available P while those under *Gmelina* had significantly the lowest available P. There were no significant differences in the labile P, Al, Fe and Ca bound P of the soil phosphorus fractions under the different tree species. The residual P and the organic P varied significantly under the tree specie. *Terminalia* and *Tectona* had greater residual P than *Gmelina*. *Terminalia* had the highest organic P, followed by *Gmelina* and *Tectona*. Tree age did not significantly affect the soil phosphorus fractions except the organic P fraction. Trees of 10-15 years old had the highest organic P while Trees 15-25 years old had the lowest organic P (Table 3). Likewise, the soil phosphorus fractions did not vary significantly across the soil depth. The subsoil, however, had greater soil organic P than the topsoil. Interactions between tree and age, tree and depth, age and depth, tree, age and depth did not have significant impact on the available P, labile P, Al/ Fe-P and Ca bound P (Table 5). Tree specie and tree age had significant interaction on the soil organic phosphorus. *Terminalia* 5-10 years old had the highest organic P fraction followed by *Gmelina* 15-25 years old while the least occurred in soils of *Tectona grandis* 5-10 years old (Table 5). Tree species and soil depth had significant effect on the soil organic P. The subsoil under the *Terminalia* had the highest organic P fraction while the lowest was obtained in topsoil under the *Gmelina* (Table 5).There was significant interaction between tree age and soil depth on the residual and organic P (Table 4 and 5). The residual P varied between 2.73 mg kg^{-1} and 5.12 mg kg^{-1} of tree 10-15 years and 15-25 years old, respectively of the subsoil. There was however no clear pattern in the order of variations of the residual P fraction under the interactive effect of tree age and soil depth (Table 4). The organic P varied from 18.96 – 36.19 mg kg-1 of 5-10 years old tree at the topsoil and 5-10 years old tree at the subsoil (Table 5).The 3-way interaction between tree specie, tree age and soil depth were significant on the organic phosphorus fraction (Table 5). Terminalia of 5-10 years old in the subsoil had the highest organic phosphorus fraction followed by Tectona of 15-25 years in the subsoil while the least occurred on the topsoil of Terminalia of 15-25 years old. Generally, soils of the various agroforestry tree species, organic P followed by the available P were the most abundant P fractions and the least was Ca bound P fraction. In term of abundance, the distribution of the soil phosphorus fractions across the tree age series and at varying soil depths, followed the same pattern as the agroforestry tree species

Table 1: Phosphorus fractions in soil under agroforestry trees as affected by tree age and soil depth

Factors		**Phosphorus fractionation**					**mg/kg**
		Avail. P	Labile P	Al and Fe bound P	Ca bound P	Residual P	Organic P
TREES	TS	29.5a	5.79	3.79	3.46	4.93a	32.12a
	TG	18.3b	5.15	4.07	2.29	4.26a	24.15c
	GA	11.7c	6.01	4.42	3.66	2.26b	27.04b
AGES	5-10	23.2	6.59	4.35	3.94	3.58	27.57ab
	10-15	17.1	4.84	3.69	2.65	3.90	30.30a
	15-25	19.2	5.52	4.24	2.85	3.98	25.44b
Depth	Topsoil	17.8	4.38	4.48	3.05	3.88	25.58b
	Subsoil	21.9	6.92	3.71	3.24	3.75	29.95a
DMRT (P≤ 0.05)							
Trees x Age		Ns	Ns	Ns	Ns	Ns	2.38
Trees x Depth		Ns	Ns	Ns	Ns	Ns	1.94
Age x Depth		Ns	Ns	Ns	Ns	2.58	1.94
Trees x Age x Depth		Ns	Ns	Ns	Ns	Ns	3.36

Tree: TS =*Terminalia superba*, TG= *Tectona grandis,* GA= *Gmelina arborea*
Means within factor group followed by same letter are not significantly different (P> 0.05)

Table 2: Effect of selected Trees depth and age intervals on soil residual phosphorus fraction

Age intervals (years)	Depth (cm)	Residual phosphorus (mg/kg)
5-10	Surface	3.75b
10-15	(0-15)	5.07a
15-25		2.83c
5-10	Subsurface	3.40b
10-15	(15-25)	2.73c
15-25		5.12a

Tree: TS =*Terminalia superba*, TG= *Tectona grandis,* GA= *Gmelina arborea*
Means followed by same letter in both columns and rows are not significantly different (P>0.05)

Table 3: Interaction of Tree species, Age intervals and soil depth on organic phosphorus fraction (mg/kg)

Trees	Ages (years)	Depth (cm)	Organic P (mg/kg) 0-15cm	15-30cm
TS	5-10		26.75ef	45.41a
	10-15		37.60c	36.97c
	15-25		12.82h	33.19d
TG	5-10		20.07g	21.86g
	10-15		28.30e	26.49ef
	15-25		36.38cd	11.77h
GA	5-10		10.05h	41.29b
	10-15		23.47fg	28.95e
	15-25		34.81cd	23.65fg

Tree: TS =*Terminalia superba*, TG= *Tectona grandis,* GA= *Gmelina arborea*
Means followed by same letter in both columns and rows are not significantly different (P>0.05)

Conclusion

The result obtained from the study showed that sinteraction between tree species and tree age, tree species and soil depth, tree age and soil depth, tree, age and depth did not have significant impact on the available P, labile P, Al/ Fe-P and Ca bound P. However there was significant interaction between tree age and soil depth on the residual and organic P. In all, the soils of the various agroforestry tree species, organic P followed by the available P were the most abundant P fractions and the least was Ca bound P fraction.

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Effect of Tillage and Groundnut on Properties of an Ultisol in Nsukka, Enugu State, Nigeria

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Abstract
The effects of tillage and groundnut on physico-chemical properties of an Ultisol were evaluated in Nsukka, an area located within the derived savannah zone of South-eastern Nigeria. The experiment was a randomized complete block design with six treatments and three replications. The treatments were – minimum tillage (Tm), conventional tillage (Tc), traditional tillage (Tt), conventional tillage + groundnut (TcG), minimum tillage + groundnut (TmG), traditional tillage + groundnut (TtG). Soil samples were collected before treatment application as well as at six and fourteen weeks after treatment application. Results showed that tillage practices significantly (P<0.05) influenced some soil properties relative to other treatments, the highest bulk density, state of aggregation, aggregate stability and CEC of 1.66Mg/m^3, 42%, 48% and 11 cmol/kg soil respectively, were obtained in soils that had minimum tillage treatments. However, soil under traditional tillage with or without groundnut planted had the highest available phosphorus. As a conservation practice, it is recommended that farmers in the study area should adopt minimum tillage and traditional tillage as against conservation tillage on ultisols.

Introduction
One of the important operations in the growth of arable crops in Nsukka area is tillage. The term tillage can be defined as the mechanical manipulation of the soil which usually results in structural changes. Tillage operations generally carried out in the cause of crop production include- traditional tillage, minimum tillage, conventional tillage, etc. By traditional tillage we mean the type of tillage practice adopted in most parts of Eastern Nigeria, including Nsukka area. This is making of either ridges, beds or mounds using Local Implements such as hoe and cutlass, in this method, the soil aggregates are not thoroughly broken down. Conventional tillage involves intensive working of the soil to produce a fine tilth which is often piled up in ridges, mounds, raised or sunken beds (Youdeowei and Adeniji, 1986). Minimum tillage on the other hand is the barest cultivation required to prepare the soil to establish a crop. It might include the use of chemical to kill the weed/existing vegetation followed by tillage to open only a narrow seed band (Morgan, 1991). The type of tillage operation carried out and use of crop residue to improve the physico-chemical properties and microbial activities of the soil are salient features of efficient rain fed farming. However, tillage operations have detrimental effect on surface soil structure. It greatly hastens the oxidation of soil organic matter thus reducing the aggregation effects of this soil component. Tillage also cost farmers a lot. According to Youdeowei and Adeniji (1986), the cost of mechanized tillage can be very high and when manually done it is a backbreaking job for farmers. There is dearth of research information on the effects of the different tillage operation practiced in Nsukka area on the physico-chemical properties of soils. The degradation of the soil due to tillage could be minimized when such tilled soils are planted with some crops like groundnut that will not only suppress weed growth but also have the potentials of improving soil properties. Adopting tillage method that will not lead to much soil degradation in groundnut production is important. This is against the backdrop of cost of hiring Labour or machines for this purpose. The objective of

this study is therefore to evaluate the effect of tillage and groundnut on selected physico-chemical properties of an Ultisol.

Materials and Methods

Description of the Experimental Site

The land used for the experiment is located within the Soil Science Research Farm of University of Nigeria, Nsukka. Ecologically, Nsukka belongs to the derived savannah zone of Nigeria and is located on latitude 6^0 52' North and longitude 7^0 24' East (Asadu et al., 2001). It has an average elevation of 447m above mean sea level and is characterized by tropical wet climate usually from the month of April to October and dry climate usually from the month of November to March. The mean annual rainfall is about 1700mm. Nsukka has high insulations with high temperatures throughout the year. The mean maximum temperature is about 35^0C while the mean minimum temperature is about 20^0C. The soil of the study area has been classified as Arenic Kandi Ustult (USDA, 1984), derived from false-bedded sandstone (Akamigbo and Igwe, 1990). The top 0-20cm soil is sandy loam.

Field Methods

The total experimental area measured 288m^2 and each experimental plot measured 4 x 4m. A bond was constructed round the experimental site to prevent inflow of water and control erosion. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replicates. The treatments were – minimum tillage (Tm), conventional tillage (Tc), traditional tillage (Tt), conventional tillage + groundnut cropping (TcG), minimum tillage + groundnut cropping (TmG), traditional tillage + groundnut cropping (TtG). In the Minimum tillage treatment, the only opening of the soil is to put in the groundnut seed, after planting groundnut atrazine was used to control weed at the rate of 2kg/ha throughout the period of the experiment, no other tillage was carried out on the plots. In the traditional tillage, hoe and cutlass were used to clear vegetation/weeds and land preparation. Plots that received traditional tillage were weeded twice using hoe before last soil sample collection at 14 weeks after treatment application. Conventional tillage was affected as stated in Brady and Weil (1999) this involved combined primary and secondary tillage using tractor, plough and harrow. The plots that received conventional tillage were weeded twice using hoes and cutlass. In all treatments involving groundnut, local variety obtained from the local market was used. Seeds were sown in a shallow drills 2.5cm deep at a spacing of 45cm x 30cm. Germination was monitored by counting the number of crops that emerged eight days after planting (DAP) and those that did not germinate were supplied.

Data Collection

Soil samples were collected before treatment application and at 6 and 14 weeks after treatment application. The methods used in their determination are described as follow: particle size distribution was determined by the Bouyoucos (1951) hydrometer method with sodium hexametaphoshate (calgon) as the dispersing agent. Bulk Density and moisture retention were determined using undisturbed core sampler. Aggregate Stability and mean weight diameter (WSA) indices where determined by the wet-sieving technique described by Kemper and Rosenau (1986). Soil pH was determined with the aid of the pH meter using a soil water ratio of 1:2.5. Soil Organic Matter (S0M) was determined using Walkley and Black (1934) method. Total Nitrogen was determined by the macro Kjedahl digestion procedure (Bremner, 1965). Exchangeable Bases were measured by leaching the soil with 0.1N NH_4 OAC solution. Calcium and Mg were determined by atomic absorption spectroscopy while K and Na were determined using flame photometry. Exchangeable acidity was determined by the method outlined by Mclean (1965). Available P was determined by Bray II method (Bray and Kurtz, 1945). Cation exchangeable capacity (CEC) was determined by the NH_4 OAC displacement method (Jackson, 1958).

Data Analysis

Data collected from the study were analysed using the method of analysis of RCBD experiments and Means were separated using Duncan's New Multiple Range Test (Obi, 1986).

Results and Discussion

Initial Properties of Soil Used for the study

The initial properties of soil used for this study is presented in Table 1. The soil is sandy in texture, strongly acid, low in N and K but high in available P. Soil of these properties are poor in nutrient status

Effects of Treatment on Selected Soil Properties

Physical properties

The effect of treatments on some soil physical properties are presented in Table 2. At 6 Weeks after treatment application (WATA), apart from soils of Tm and TmG treatments, all treatments reduced bulk density and increased total porosity relative to the initial values before treatment application. But at 14 WATA, the bulk density of all the soils from all treatment was lower than the initial value before treatment application. Treatments under TcG, Tc and TtG had the least bulk density and total porosity at all sampling periods. Soils of Tm and TmG treatments had the highest ($P<0.05$) aggregate stability. The decrease in total porosity of soils for some of the treatments may be due to reconsolidation and settlement occasioned by rain drop impacts (Onwualu and Ahaneku, 2001). In general, the conservational tillage practice of Tm and Tt exhibited soil moisture content significantly higher ($P<0.05$) than that for other treatments. The higher moisture retention in plots under minimum tillage and traditional tillage is attributed to the reduced soil manipulation, and higher organic matter content of these soils. On the other hand, the conventional tillage practice involves more soil pulverization and destruction of organic matter, thus Leaving soil exposed. All these combine to give more evaporation, infiltration, percolation, and hence less moisture retention at the surface soil. This finding agrees with results obtained elsewhere in Nigeria (Lal, 1979; Anazodo et al., 1991). The high aggregate stability of soils of Tm, TmG and TtG treatments may be attributed to the binding power of soil organic matter which is higher in soils of these treatments. Piccolo (1996) explained the beneficial contribution of the hydrophobic bonding of S0C in soils. Igwe et al. (1999) also, showed that S0C contributes significantly to macro aggregate stability in some soils of the tropics irrespective of their proportion in the soil. Also, Mbah and Mbagwu (2003) showed that a significant structural stability can be achieved when soils are amended with organic matter.

Soil chemical properties

Effect of treatment application on soil chemical properties is given in Table 3. Soil pH, for all treatments were generally lower than the initial value before treatment application. This general decrease may be attributed to the leaching effect or production of acidic material by micro organisms and roots of higher plants (Brady and Weil, 1999). The soil under minimum tillage was higher in acidity relative to other soils. Organic carbon values were generally higher after treatment application in all treatments. Also, soil under Tm had the highest ($P<0.05$) organic matter content. This may be as a result of the decomposition of the crop residues incorporated into the soil during the tillage and also the organic residues left on the plots on minimum tillage. Exchangeable bases Ca, Mg, K, and CEC Na were lower in soils under the different treatments when compared with the soil content of these cations before treatment application (BTA). The decrease in exchangeable bases, may be attributed to plant uptake of these bases. Annual losses from plant removal as great as 400kg/ha or more of potassium are not uncommon especially if there is a legume in the field (Brady and Weil, 1999). The decrease in exchangeable bases may also, be as a result of decrease in soil pH. Cation exchange capacity has a negative correlation with soil pH (Brady and Weil, 1999). The available phosphorus (p) of soil under different treatments were much lower than the values before treatment application. This can be attributed to plant uptake and fixation of available P due to high soil acidity . Soil available P under TtG and TcG treatments were significantly higher ($p < 0.05$) than that of other treatments. Also, total N content of soils were higher ($P>0.05$) in those soils having groundnut. The higher values obtained from these soils planted with groundnut may be attributed to the beneficial effect of groundnut, a Nitrogen fixing leguminous crop (Nnadi et al., 1981).

Conclusion

This study shows that intercropping maize with groundnut under minimum tillage and traditional tillage methods of land preparation can relatively conserve soil physical properties relative to conventional tillage as observed in the improved state of aggregation and aggregate stability of the soil. Traditional tillage also increased soil CEC relative to the other tillage methods.

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Table 1: Initial properties of the Soil used for the experiment

Soil property	Value	Soil property	Value
Particle size distribution (%)		pH(H_2O)	4.5
		pH (KCL)	3.8
Coarse sand	45	Organic carbon(%)	1.37
		Tot. N (%)	0.084
Fine sand	29.62	Exchangeablebases (cmol/kg)	
Silt	5.28	Na	0.26
Clay	20.5	K	0.07
Texture	Sandy loam	Ca	4.6
		Mg	1.2
Bulkdensity (Mg/m^3)	1.62		
Aggregate stability (%)	49	Avail. P (mg/kg)	27

Table 2: Effect of treatment on bulk density, total porosity, aggregate stability and moisture content

TreatMent		Bd (Mg/m^3)	Tot. Porosity (%)	SA (%)	AS (%)	Moisture content (%)
6WATA	Tm	1.66^b	37^a	41^b	48^b	8^b
	TcG	1.33^a	50^b	35^a	41^a	6^a
	TtG	1.34^a	49^b	37^a	45^{ab}	7^a
	TmG	1.65^b	38^a	40^b	47^b	8^b
	Tc	1.34^a	49^b	36^a	43^a	6^a
	Tt	1.35^a	49^b	35^a	40^a	7^a
	Mean	1.45	45	37	44	7
14WATA	Tm	1.51^b	39^a	42^b	48^b	9^b
	TcG	1.41^a	46^b	32^a	38^a	6^a
	TtG	1.47^a	45^b	44^b	47^b	8^b
	TmG	1.50^b	39^a	43^b	48^b	8^b
	Tc	1.45^a	45^b	31^a	37^a	7^{ab}
	Tt	1.49^b	43^b	39^{ab}	46^b	8^b
	Mean	1.47	43	39	44	8

Tm = Minimum tillage; TcG = Conventional tillage + Groundnut; TtG = Traditional tillage + Groundnut; TmG = Minimum tillage + Groundnut; Tc = Conventional tillage; Tt = Traditional tillage; WATA=Weeks after treatment application; SA=state of aggregation; AS= Aggregate stability. Means followed by the same letter are not significantly different at $P< 0.05$ using Duncan's New Multiple Range Test.

Table 3: Effect of treatment on soil chemical properties 3MATA

Treatment	pH H_2O	KCL	OC (%)	Tot. N (%)	Avail. P (mg/kg)	Exch. Bases (cmol/kg)				CEC (cmol/kg)
						Na	K	Ca	Mg	
Tm	3.8^a	3.2^a	2.05^a	0.032^a	5.60^a	0.3^a	0.04^a	1.2^a	0.4^a	10.9^b
TcG	4.1^a	3.4$^{a.}$	1.75^a	0.041^a	8.39^b	0.18^a	0.03^a	1.6^a	0.5^a	8.2^a
TtG	4.0^a	3.2^a	2.07^a	0.045^a	10.26^b	0.17^a	0.02^a	1.4^a	0.7^a	9.8^b
TmG	3.9^a	3.1^a	2.03^a	0.033^a	5.60^a	0.20^a	0.03^a	2.0^a	0.4^a	9.0^a
Tc	4.1^a	3.1^a	1.79^a	0.030^a	7.80^a	0.16^a	0.03^a	1.5^a	0.8a	8.7^a
Tt	4.0^a	3.0^a	2.01^a	0.017^a	8.39^b	0.13^a	0.04^a	1.2^a	0.4a	8.8^a
Mean	4.0	3.2	2.00	0.0135	7.64	0.19	0.03	1.5	0.5	9.7

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Effect of Lime and Organic Matter Interaction on the Yield of Turmeric on an Ultisols of South-Eastern Nigeria

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Abstract

The field experiments were conducted at the National Root Crops Research Institute Farms at Umudike, Abia State, Southeastern Nigeria (Latitude 5o 29′ N and Longitude 7o 32′ E, with an altitude of 122 m above sea level) during the 2014, 2015 and 2016 cropping seasons. The land area was marked into three blocks with 1m spacing between the blocks. Each block was further marked into 9 plots of beds measuring 3 m x 2 m (6 m) with 1m spacing. The experiment was laid out in a randomized complete block design (RCBD) with three replicates. Treatments were applied only in 2014 and 2015, and comprised poultry manure (PM) and lime (LM) in t/ha. This resulted in nine treatments combinations (Control, 0 LM +10 PM, 0 LM +20 PM, 1 LM + 0 PM, 1 LM +10 PM, 1 LM +20 PM, 2 LM +0 PM, 2 LM +10 PM and 2 LM +20 PM). The treatments were incorporated in the seedbeds 14 days before planting. The planting was carried out at a planting spacing of 25cm x 50cm. Mulching was done within two days after. Gramozone with premextra was applied pre-emergence and weeded ones and supplemented with rouging. Lime treatments were broadcasted immediately after planting. A basal dressing of fertilizer application - 200kg/ha NPK (15:15:15) was added 4 weeks after planting. A composite soil sample of the experimental plot at the beginning of the field experiment as well as individual soil samples from each plot at the end of the experiment were collected at a depth of 0-15cm and processed for laboratory analysis. Harvesting of fresh rhizomes was done at 8 months after planting. The data was subjected to combined ANOVA for the three year data. Significant means were separated using the LSD at 5% alpha level. Application of Lime and poultry manure significantly (P < 0.05) influenced the rhizome yield of turmeric. Turmeric rhizome yield showed significant increases over the control, with increasing rates of poultry manure application. It was observed in this 1st year of treatment application (2014 cropping season) in Umudike that the total rhizome yield was significantly (P< 0.05) higher in plots that received poultry manure ranging from 7.54 t/ha to 12.71 t/ha with an average of 9.61 t/ha as compared with treatment without poultry manure and control which ranges from 5.20 t/ha to 6.3 t/ha with an average of 5.72 t/ha. Further observation during this 1st year cropping season was that the plots that received the highest amount of poultry manure (20 t/ha) gave the highest values of 9.87 t/ha, 11.65 t/ha and 12.71 t/ha of rhizome yield irrespective of lime rate, respectively. The above mentioned trends were also observed in the 2nd and 3rdyear planting seasons (2015 and 2016). Result of the combined analysis indicated that 20 t/ha poultry manure, irrespective of the lime rate, increases significantly (p < 0.05) turmeric rhizome yield over all the other treatments and control. The highest yield and yield parameters were obtained at lime rate of 1t/ha in combination with 20 t/ha of poultry manure. The residual impact of PM and lime on morphological growth and yield of turmeric was demonstrated in this study as tested parameters in 2016 were not significantly (P< 0.05) inferior to that of 2014.

Introduction

The Umudike soils are Ultisols and are classified as Arenic Kandiudult (Akpan-Idiok *et al*., 2012). They are strongly acidic, low in C.E.C, low in base saturation and poor in nutrient (Ita and Esu, 2013; Osodeke, 2017). They are highly leached upland ferralitic soils with kaolinite as dominant clay type. Optimum soil management for any purpose requires that soil pH be adjusted to acceptable range (Sims, 1996). Among the conditions associated with adequately limed soil are an adequate base saturation of soil's cation exchange capacity (C.E.C), the neutralization of potentially phytotoxic elements (e.g Al, Fe, Mn), the reduction in solubility of hazardous trace elements in waste-amended soils (e.g Cd, Cr, Cu, Ni, Pb and Zn). Besides, lime provides calcium which is a macro-element essential for membrane permeability, solutes transport and maintenance of cell integrity (Marchner, 1986). Organic matter application is an alternation method and superior to lime in reducing the effect aluminum toxically in acid soils (Ahmad and Tan, 1986). The organic matter content of soil also contributes to soil acidity and lime requirement because there is difference in the nature of soil acidity associates with organic matter and clay (or Fe and Al oxides), the need for lime and the means to assess lime requirement differs as well. All of soil acidity associated with organic matter on pH dependent C.E.C sites of organic functional groups such as carboxylic acid and phenols. Consequentially, most studies have shown that not only does lime requirement in soil increase with organic matter content in general, but that in soil with high organic matter contents, lime requirement increases more dramatically as target pH is raised than occurs in high clay soil (Sims,1996) . Therefore, it is the objectives of this study to ascertain the effect lime and organic matter on the yield of turmeric as well as the optimum rate of lime and organic matter application for turmeric production

Materials and Methods

The field experiments were conducted at the National Root Crops Research Institute Farms at Umudike, Abia state, Southeastern Nigeria (Latitude 5° 29′ N and Longitude 7° 32′ E, with an altitude of 122 m above sea level) during the 2014, 2015 and 2016 cropping seasons. The land area was marked into three blocks with 1m spacing between the blocks. Each block was further marked into 9 plots of beds measuring 3 m x 2 m (6 m) with 1m spacing. The experiment was laid out in a randomized complete block design (RCBD) with three replicates. Treatments were applied only in 2014 and 2015, and comprised poultry manure (PM) and lime (LM) in t/ha. This resulted in nine treatments combinations (Control, 0 LM +10 PM, 0 LM +20 PM, 1 LM + 0 PM, 1 LM +10 PM, 1 LM +20 PM, 2 LM +0 PM, 2 LM +10 PM and 2 LM +20 PM). The treatments were incorporated in the seedbeds 14 days before planting. The planting was carried out at a planting spacing of 25cm x 50cm. Mulching was done within two days after. Gramozone with premextra was applied pre-emergence and weeded ones and supplemented with rouging. Lime treatments were broadcasted immediately after planting. The fertilizer treatments were applied 2 weeks after planting (WAP). A composite soil sample of the experimental plot at the beginning of the field experiment as well as individual soil samples from each plot at the end of the experiment were collected at a depth of 0-15cm and processed for laboratory analysis. A basal dressing of fertilizer application - 200kg/ha NPK (15:15:15) was added 4 weeks after planting. Harvesting of fresh rhizomes was done at 8 months after planting. The data was subjected to combined ANOVA for the three year data. Significant means were separated using the LSD at 5% alpha level. Data on total rhizome yield are only presented in this report.

Table 1: Physio-chemical properties of the soil used for the study

Properties	Values
Sand (%)	67
Silt (%)	7
Clay (%)	26
Texture	Sandy clay loam
pH (H_20)	5.30
pH (KCl)	4.11
Exchangeable Calcium (cmol/kg)	2.5
Exchangeable Magnesium (cmol/kg)	1.6
Exchangeable Potassium (cmol/kg)	0.092
Exchangeable Sodium (cmol/kg)	0.082
Exchangeable Aluminum (cmol/kg)	2.4
Exchangeable Hydrogen (cmol/kg)	1.4
Total exchangeable acidity (cmol/kg)	3.8
Organic carbon (%)	1.91
Total Nitrogen (%)	0.085
C/N ratio (%)	22.73
Effective cation exchangeable capacity (cmol/kg)	7.90
Available Phosphorus (mg/kg)	20.0
Base saturation (%)	52

Results and Discussion

The soil test results of the experimental site (Table 1) showed that the textural class is sandy clay loam and the pH was 5.30 indicating that the soil was acidic with low amount total nitrogen. The organic carbon, total exchangeable bases and effective cation exchange capacity is moderately low. The soil has high exchangeable acidity and moderate base saturation. Available phosphorus was 20.0 mg/kg which exceeded the critical level of 15 mg/kg established for crops in Southeastern Nigeria (Enwezor et al., 1990). Despite the fact that the pre-plant soil test result indicated deficiencies in most major plant nutrients (1.71% OM, N (NA), 19.8ppm P, K 0.215), the yield and yield parameters of Turmeric were significantly affected by the applied Lime and poultry manure in the 3 years (Tables 2, 3 and 4). While the year effect was significant, performance in 2015 was significantly higher than that 2014 and 2016 (Table 5). Application of Lime and poultry manure significantly ($P < 0.05$) influenced the rhizome yield and yield components of turmeric. However, treatment application in 2015 resulted in significant ($p < 0.05$) increase in rhizome yield and yield components than the value obtained in 2014. Furthermore, in combined analysis, LM+PM had significant ($p < 0.05$) higher total RY relative to sole applications and the control. This observation is consistent with the earlier findings of Sanwal *et al.*, 2007 who showed the benefit of integrated plant nutrient over sole fertilizer used in turmeric production. Similar findings were obtained in respect to other crops such as tomato (Ayeni *et al.*, 2010), amaranthus (Nwajiaku and Asadu, 2012), ginger (Ohaeri, 2016). Turmeric rhizome yield showed significant increases over the control, with increasing rates of poultry manure application ranging from 7.54 t/ha to 12.71 t/ha with an average of 9.61 t/ha as compared with treatment without poultry manure and control which ranges from 5.20 t/ha to 6.3 t/ha with an average of 5.72 t/ha. In the 1st year cropping season (Table 2) the plots that received the highest amount of poultry manure (20 t/ha) gave the highest values of 9.87 t/ha, 11.65 t/ha and 12.71 t/ha of rhizome yield irrespective of lime rate, respectively. The above mentioned trends were also observed in the 2nd and 3rd year planting seasons (Tables 3 and 4). Result of the combined analysis indicated that 20 t/ha poultry manure, irrespective of the lime rate, increases significantly ($p < 0.05$) turmeric rhizome yield over all the other treatments and control. The highest yield and yield parameters were obtained at lime rate of 1t/ha in combination with 20 t/ha of poultry manure. The residual impact of PM and lime on yield and yield of turmeric was demonstrated in this study as tested parameters in 2016 were not significantly ($P< 0.05$) inferior to that of 2014.

Table 2: Effect of lime and poultry manure on the yield and yield components of turmeric in 2014

Treatment (t/ha)	Mother rhizome no/ha ($x10^3$)	Mother rhizome yield (t/ha)	Primary rhizome no/ha ($x 10^3$)	Primary rhizome yield (t/ha)	Secondary rhizome no/ha ($x 10^3$)	Secondary rhizome yield (t/ha)	Total rhizome no/ha ($x 10^3$)	Total rhizome yield (t/ha)
Control	115.4	1.10	403.1	2.66	631	1.44	1150	5.20
0LM+10PM	141.0	1.75	431.9	4.10	936	2.33	1508	8.18
0LM+20PM	120.5	2.10	874.1	5.55	968	2.21	1962	9.87
1LM+0PM	94.4	1.10	454.2	2.66	414	1.33	962	5.10
1LM+10PM	116.6	1.55	499.2	3.88	677	2.33	1628	7.76
1LM+20PM	191.5	3.10	530.3	5.55	1578	3.00	2300	11.65
2LM+0PM	109.0	1.55	507.8	3.11	706	1.66	1325	6.30
2LM+10PM	152.1	1.66	534.2	3.99	871	1.88	1558	7.54
2LM+20PM	172.1	2.77	713.6	6.27	1100	3.66	1985	12.71
LSD (0.05)	80.0	0.81	NS	0.73	504	1.35	1012	2.65

LM = lime; PM = poultry manure

Table 3: Effect of lime and poultry manure on the yield and yield components of turmeric in 2015

Treatment (t/ha)	Mother rhizome no/ha ($x10^3$)	Mother rhizome yield (t/ha)	Primary rhizome no/ha ($x 10^3$)	Primary rhizome yield (t/ha)	Secondary rhizome no/ha ($x 10^3$)	Secondary rhizome yield (t/ha)	Total rhizome no/ha ($x 10^3$)	Total rhizome yield (t/ha)
Control	133	2.47	825.9	4.70	775	2.23	1737	9.4
0LM+10PM	220	3.33	661.4	5.47	1097	3.13	1979	12.0
0LM+20PM	233	5.33	1271.7	13.23	1705	5.43	3210	24.0
1LM+0PM	128	1.90	274.9	2.33	588	1.67	990	5.9
1LM+10PM	214	4.33	703.1	6.47	1324	4.20	2241	15.0
1LM+20PM	297	4.87	1044.6	11.90	2252	8.70	3560	25.5
2LM+0PM	206	2.43	375.9	3.33	1104	3.77	1686	9.5
2LM+10PM	161	2.48	442.6	4.57	1068	3.47	1689	10.5
2LM+20PM	325	5.43	1222.3	12.03	1518	6.83	3068	24.3
LSD (0.05)	144.8	2.17	726.84	4.50	932.9	3.41	1107.9	6.8

LM = lime; PM = poultry manure

Table 4: Effect of lime and poultry manure on the yield and yield components of turmeric in 2016

Treatment (t/ha)	Mother rhizome no/ha ($x10^3$)	Mother rhizome yield (t/ha)	Primary rhizome no/ha ($x 10^3$)	Primary rhizome yield (t/ha)	Secondary rhizome no/ha ($x 10^3$)	Secondary rhizome yield (t/ha)	Total rhizome no/ha ($x 10^3$)	Total rhizome yield (t/ha)
Control	87.74	0.78	199.36	1.00	245	1.00	532.10	3.17
0LM+10PM	129.95	1.44	293.77	1.89	811	1.65	1235.0	6.44
0LM+20PM	132.17	1.55	477.03	2.33	621	1.72	1231.0	7.44
1LM+0PM	188.10	1.22	243.34	1.55	283	0.78	714.44	4.22
1LM+10PM	188.81	1.94	375.96	2.50	734	2.17	1298.7	8.05
1LM+20PM	224.35	2.33	690.28	3.61	1065	2.22	1979.6	8.72
2LM+0PM	117.18	1.55	379.85	2.28	504	2.16	1001.8	6.50
2LM+10PM	123.28	1.44	397.06	1.89	505	1.39	1025.0	5.61
2LM+20PM	191.03	1.06	433.16	2.28	633	1.83	1257.1	6.56
LSD (0.05)	133.16	1.20	404.94	1.58	473.5	1.24	635.0	3.59

LM = lime; PM = poultry manure

Table 5: Combined effects of lime and poultry manure on the yield and yield components of turmeric across the years

Treatment (t/ha)	Mother rhizome no/ha ($x10^3$)	Mother rhizome yield (t/ha)	Primary rhizome no/ha ($x 10^3$)	Primary rhizome yield (t/ha)	Secondary rhizome no/ha ($x 10^3$)	Secondary rhizome yield (t/ha)	Total rhizome no/ha ($x 10^3$)	Total rhizome yield (t/ha)
Control	145.6	1.43	491	2.79	550	1.56	1139.70	5.92
0LM+10PM	163.8	2.17	462	3.82	948	2.38	1574.0	8.87
0LM+20PM	162.0	3.00	874	7.04	1098	3.12	2134.0	13.77
1LM+0PM	103.3	1.40	309	2.18	428	1.26	889.14	5.07
1LM+10PM	184.9	2.60	526	4.28	912	2.90	2155.18	10.37
1LM+20PM	225.8	3.43	669	7.04	1632	4.64	2613.54	15.28
2LM+0PM	168.7	1.84	525	2.91	7711	2.53	1336.94	7.44
2LM+10PM	145.6	1.85	458	3.48	815	2.25	1424.0	7.88
2LM+20PM	204.9	3.04	772	6.86	1083	4.11	2102.39	14.52
LSD (0.05)	67.14	0.83	321	1,58	367	1.22	515.20	2.57
2014	134.7	1.85	550	4.2	876	2.20	1598	8.26
2015	213.1	3.61	758	7.11	1270	4.38	2240.0	15.12
2016	153.7	1,47	388	2.15	600	1.66	1141.0	6.30
LSD (0.05)	44.7	0.54	NS	3.01	390	1.13	810.0	4.37

LM = lime; PM = poultry manure

Conclusion

From the result obtained, it was confirmed that turmeric unlike other minor root crops is not adapted to marginal lands. The use of organic manure for turmeric production in Umudike soil is imperative. The highest yield and yield parameters were obtained at lime rate of 1t/ha in combination with 20 t/ha of poultry manure. The residual impact of PM and lime on yield and yield components of turmeric was demonstrated in this study as tested parameters in 2016 were not significantly ($P< 0.05$) inferior to that of 2014. If mixed fertilizers (poultry manure+NPK) is use lime need to be applied,

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SUB-THEME 6


FISHERIES AND
AQUACULTURE,
PRODUCTION, NUTRITION,
GENETIC IMPROVEMENT
AND POST HARVEST
TECHNOLOGIES

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Assessment of Poultry Viscera as Potential Ingredients in Fish Feed formulation

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Abstract
*The poultry visceral used was obtained from Sokoto meat market slaughter site. The viscera was thoroughly washed with the digesta being removed from the intestine of which some fresh quantities were crushed together to be homogenous in quantity and taken to the laboratory immediately for analysis. Four experimental diets were formulated following Pearson square method. The diets were isonitrogeneous containing (45% crude protein). The results of the proximate composition of poultry viscera show that the boiled viscera had the least moisture content (6.63±0.88%). The highest moisture content (77.67±0.33%) was recorded in fresh samples. The ash, crude fiber, and NFE follow the same trend. The boiled sample recorded the highest value of crude protein (41.12±0.01%) and crude lipid (15.51±0.01%) respectively whereas the fresh sample recorded the least content in the same order. The results of the formulated diets were Diets containing 15% level of substitution recorded highest moisture content (6.17±0.26%) and diets containing 30 and 45% level of substitution recorded the least values (5.57±0.29 and 5.62±0.08%) respectively. Diets containing 45% level of substitution recorded the highest crude protein content (43.14±1.55) and differed (P>0.05) significant from other dietary treatments. Diets containing 0% and 15% level of substitution recorded the least crude protein values (30.20±0.58 and 29.20±1.06%**)** respectively. Diets containing 45% level of substitution recorded the highest crude lipid of 9.23±0.80% and differed (P>0.05) significant from other dietary treatments. Diets containing 0% and 15% level of substitution recorded the least crude lipid values (6.22±0.30 and 5.96±0.43%) respectively. Feeding trial should be considered in order to evaluate the biological performance of these diets in growth and nutrients utilization.*

Key words: Fish feed, animal protein, nutritional values and non-conventional animal resources

Introduction
The global demand for fish from consumers around the world is increasing, reasons include, the growing population, rising average incomes and greater awareness of fish as part of a healthy diet (Hossain, 2010). The yield from the wild catch cannot be increased sustainably, therefore, in the opinion of observers such as the Food and Agriculture Organization FAO (2008), aquaculture must fill the gap. Currently the supply of fish from aquaculture approximately matches that from the wild (FAO, 2008). Domestic production base for feed premixes, binders, additives, as well as for concentrates, is quite pathetic and it is far behind requirements (Pratyush *et al*., 2014). Due to the lack of scientific and professional management, the quality of the produced feeds is often poor. Except some large-scale feed mills, most of the feed mills do not have skilled employees (Pratyush *et al*., 2014). Nowadays fish farming is leading towards the semi intensive or intensive culture (Pratyush *et al*., 2014). Equally, formulated feed inputs are shifted from farm made feeds to factory made feeds. The farmers depend only on the information given by the feed industry, about the feed composition and its effect on growth performance of fish (Pratyush *et al*., 2014). So there is a huge threat, that the farmers will be swindled by the feed manufacturer. It is very important to identify the nutritional requirements for optimum growth of a fish species as well as in formulating a balanced diet. Accurate dietary protein and energy levels are known to influence

the growth and body composition of fish (Steffens, 1994). A lot of the animal origin fish feed ingredients are considered as protein supplements, such feed ingredients are fish meal, fish silage, bone meal, fish viscera, poultry viscera, oyster shell meal, silkworm pupae, crab meal, snail muscle etc (Pratyush *et al*., 2014). Fishmeal is a high protein supplement feed ingredient (Ravindran *et al*., 1993). It is made from flesh, bones and offal of fresh or processed fish (Ravindran *et al*., 1993). It is used chiefly in diets for domestic animals and also as a high quality organic fertilizer (Cai *et al*., 1994). Poultry viscera are among such animal origin protein sources that can replace fishmeal (Webster *et al*., 1999, 2000; Gaylord and Rawles, 2005; Muzinic *et al.,* 2006; Rawles *et al.,* 2006; Thompson *et al.,* 2007). Viscera are the organs inside the body, such as the heart, lungs and stomach, etc. Research findings has revealed that recycling of wastes from poultry slaughterhouses is of economical, biological and environmental importance (Escalona *et al.,* 1987; Dale *et al*., 1993, Bohnert *et al*., 1999). The aim of this study is to assess the poultry viscera as potential ingredient in fish feed formulation.

Material and methods

Experimental Site

The site of the experiment was the fish feed mill and agricultural chemical laboratory of Usmanu Danfodiyo University, Sokoto which is located in the North-west part of Nigeria between longitudes 4^0 8E and 6^0 54E and latitude 12^0 N and 13^0 56N and annual rainfall ranging between 500mm to 1,300mm.The maximum and minimum temperature which are 35^0 and 41^0C respectively, (Singh, 1995).

Collection of ingredients

Feed ingredients were procured from Sokoto central market. The major feed ingredients used were as follows: yellow maize, fish meal, groundnut cake, blood meal. Others include mineral premix, lysine, palm oil, bone meal, Methionine and common salt, so also the poultry viscera.

Processing of poultry visceral

The poultry visceral used was obtained from Sokoto meat market slaughter site. The viscera was thoroughly washed with the digesta being removed from the intestine of which some fresh quantities were crushed together to be homogenous in quantity and taken to the laboratory immediately for analysis, and the remaining quantities were then boiled to remove fatty matter and to increase palatability and then air dried for 48hrs. The dried-product was grounded, taken to the laboratory immediately for analysis and meal was stored in a polythene sack to avoid spoilage (Pratyush, 2014)

Diet Formulation

This is the method of combining selected ground feed ingredients in varying proportions to comply with predetermined nutrient requirements. Each feed ingredients selected were then processed, then measured according to the suitable predetermined quantity and then compounded through a process of mixing (with the aid of an electric mixer), gelatinization and pelleting.

Table 1 Gross Composition of Diets

Ingredients	DIET I (0%)	DIET II (15%)	DIET III (30%)	DIET IV (45%)
Maize	28.02	21.95	16.46	3.97
Fish meal	40.92	33.53	24.07	13.99
Groundnut cake	16.36	17.88	19.25	22.38
Blood meal	8.18	8.94	9.62	11.19
Palm oil	2.0	2.0	2.0	2.0
Poultry visceral	-	11.17	24.075	41.96
Vitamin premix	0.5	0.5	0.5	0.5
Salt	0.25	0.25	0.25	0.25
Mineral premix	0.5	0.5	0.5	0.5
Bone meal	2.25	2.25	2.25	2.25
Methionine	0.5	0.5	0.5	0.5
Lysine	0.5	0.5	0.5	0.5
TOTAL	100	100	100	100
Crude protein levels	45	45	45	45

Proximate Analysis of Feed Ingredients and Diets
Proximate analysis for the chemical evaluation of the feed ingredients, including the poultry viscera and formulated diet were carried out in accordance to the AOAC (1990) procedures. Triplicate samples of each diet were used to determine the following chemical compositions:
Moisture: Moisture was determined by keeping 2 g of the commercial fish feed samples in a thermostat oven at 105°C for 24 h. The difference between the initial weight and the final weight gave the moisture content.
Crude protein: Samples (2 g) were digested in digestion unit (Digester, model 2020) for 45 min. The digester is then distilled in distillation unit (Khjeltdah System, Distilling unit, model 1026). Finally, it is titrated with 0.2 N HCL and crude protein were obtained by multiplying the total nitrogen by a conversion factor of 6.25.
Crude lipid: Crude lipid was determined by extracting a weighed quantity of sample with acetone in Sechelt Extraction Unit (model 1045).
Ash: Ash content was determined by igniting feed samples in a muffle furnace at 450°C overnight.
Crude fibre: Samples (2g) were digested with 0.128 M H_2SO_4 with a few drops of octanol in digestion unit (Hot Extractor, Model-1017) for 30 min. filtering and washing with boiling water removed acid. Residue was boiled with 0.223 M KOH for 30 min, then washed in boiling water and acetone. The residue was dried in an oven at 130°C for 2hrs and ignited in muffle furnace at 500°C for 3hrs. The loss of weight represented the crude fibre.
Nitrogen free extracts (NFE): NFE were calculated by subtracting the sum of moisture, crude protein, crude lipid, ash and crude fibre from 100 (Castell and Tiews, 1980).
Statistical Analysis
All the data obtained were subjected to analysis of variance (ANOVA) and the treatment means were separated using Duncan Multiple Range Test (Steel and Torrie, 1980). The analysis was carried out using SPSS version 20.0.

Results and Discussion

Proximate Composition of Poultry Viscera
The fresh poultry viscera were found to have an ash content of (4.65%) and fiber content of (1.17%). Obradovic (1969) reported very close values of 4.7% ash content of fresh (raw) poultry viscera. The fiber also lowers than the 5% base line for crude fiber ingredients for monogastric animals (NRC, 1993). The crude protein content of the fresh poultry viscera was found to be very low which was contrary to that of Obradovic (1969).The reason for this low protein content might be the species of poultry , the system used in rearing the poultry, the environment as well as poor dietary composition of feed fed by the poultry. The results of the proximate composition of the poultry viscera (Table 2) indicated that, the boiled poultry viscera was high in crude lipid and crude protein content with values of 15.51 and 41.12% respectively. These values were contrary to those of Pratyush *et al.* (2014) who reported 12.25% for crude lipid and 60.67% crude protein after air-drying without boiling and Vincent *et al.* (2016) who reported 22.0% for crude lipid and 35.0% crude protein after boiling without drying. The nature of processing would have resulted in the intermediate value for both the crude lipid and protein, this is because much of the protein and lipid will be lost during boiling but when dried the crude lipid and protein content increased as seen in Pratyush *et al.* (2014). Also the ash content of the boiled poultry viscera was lower than those of Pratyush *et al.* (2014) and Vincent *et al.* (2016). The method of processing might be the reason but the crude fiber content of this finding was slightly different from that of Pratyush *et al.* (2014) and was lower than 5% base line for crude fiber ingredients for monogastric animals (NRC, 1993).

Proximate Composition of Diets
The results of the proximate composition of the diets (Table 3) shows that diet I has a high ash (13.13%) and fiber content (4.32%) than those of Pratyush *et al.* (2014). These high values of both ash and fiber content were also observed in diets II, III and IV in contrast with those of Pratyush *et al.* (2014). The reason for these high values in the present study may be attributed to the high ash and fiber content of the various ingredients used in formulating the diet as well as the percentage contribution of nutrients by the ingredients in the diet. The crude protein content of diet I and II were lower than those of Pratyush *et al.* (2014) whereas that of diet III and IV were higher, this can be attributed to the crude protein content of fishmeal and poultry viscera, their percentage contribution of nutrients in the diets included in the diet as well method of

processing (poultry viscera and fishmeal), the species of poultry where the viscera is gotten from the type of water body(marine or fresh water) from where the fish which is being processed into fishmeal is obtained as well as poor dietary composition of feed fed by the poultry and the fish. Similarly, the crude protein, lipid and moisture content of diet I and III (0% and 30% poultry viscera respectively) were lower those reported in Vincent *et al.* (2016) as seen in his diet I and II containing 0% and 30% poultry viscera substituting fishmeal whereas the Nitrogen Free Extract (NFE) in the fore mentioned diets were higher than those of Vincent *et al.* (2016). These might be attributed to method of processing, source of ingredients used and the percentage contribution of nutrients from ingredients used in the diets formulation might be the reason. The moisture and lipid content of all the diets were lower than those reported by Pratyush *et al.,* (2014). The drying method and duration might be the reason in the case of moisture content as well as the method of processing (poultry viscera and fishmeal), the species, the type of poultry where the viscera is gotten from, the type of water body (marine or fresh water) from where the fish which is being processed into fishmeal is obtained as well as poor dietary composition of feed fed by the poultry and the fish. The Nitrogen Free Extract (NFE) in diets I, II and III differ much from that of of Pratyush *et al.,* (2014), but that of diet IV was lower than the report of Pratyush *et al.* (2014) which may be due to the percentage contribution of nutrients by poultry viscera and fishmeal in the diet.

Table 2: Proximate Composition of Poultry Visceral

TRT	Moisture%	Ash%	Crude Fiber%	Crude Protein%	Crude Lipid%	NFE%
Fresh	77.67±0.33	4.65±0.87	1.17±0.09	13.65±0.03	3.58±0.04	77.39±0.02
Boiled	6.63±0.88	0.50±0.01	0.01±0.00	41.12±0.01	15.51±0.01	36.37±0.01

Table 3: Proximate composition of Experimental diets

Composition%	**Experimental diets**			
	Diet I (0%)	**Diet II (15%)**	**Diet III (30%)**	**Diet IV (45%)**
Moisture	5.93±0.13^{ab}	6.17±0.26^{a}	5.37±0.29^{b}	5.62±0.08^{b}
Ash	13.13±0.13^{a}	13.86±0.33^{a}	12.31±0.92^{a}	9.75±0.40^{b}
Crude fiber	4.32±0.98^{b}	3.74±0.24^{b}	5.67±0.21^{a}	3.93±0.10^{b}
Crude protein	30.20±0.58^{c}	29.20±1.06^{c}	36.00±0.55^{b}	43.14±1.55^{a}
Crude lipid	6.22±0.30^{b}	5.96±0.43^{b}	6.69±0.10^{b}	9.23±0.80^{a}
Nitrogen free extra	39.31±2.13^{a}	40.76±0.66^{a}	33.46±0.43^{b}	22.78±0.43^{c}

Means in columns with the same letters are not significantly different (P >0.05)

Conclusion

From the present study, it can be concluded that boiled poultry viscera having a crude protein content of 41% and crude lipid content of 15% could serve as protein supplement; also the low moisture content of 6% will allow a longer storage period without spoilage for some period of time without immediate use in fish diet formulation. It can also be deduced that substitution level with 45% poultry viscera is appreciable percentage among all the dietary treatments. It recommended that Feeding trial should be considered in order to determine the effect of this diet on the growth performance and nutrient utilization of the culturable fish species

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Assessment of Socio-Economic Profile, Fish Feed and Feeding Practices in New Bussa Metropolitan, Niger State, Nigeria

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Abstract
The study of socio-economic characteristics, feed and feeding practices was conducted in New Bussa metropolitan, Niger State, Nigeria. The primary data was collected through structural questionnaires and interview of the farmers while secondary data was obtained from journals, books and internet. Data obtained was subjected to descriptive statistical analysis. The result of socio-economic characteristics revealed that 94% of the farmers were within working age group of 21-60 years while 48% of the farmers were within age group of economically productive age. Majority of farmers (72%) were married, majority of the farmers were males while considerable number had secondary education 48% and tertiary 36%. The year of experience of most farmers was 1-5 years which represent 65%. The study further revealed that 76% has no formal training on fish farming. Result for feed and feeding shows that 56% preferred culture hybrid catfish while majority (90%) use earthen pond as culture facility, types of feed majorly used is both floating and sinking pellet. Choice of feed is due to better body weight gain, low cost and readily available while 72% determine their diet formulation with very low consultation from fisheries experts (16%) . Feeding practices indicated that 86% of farmers in the study area preferred feeding to satiation by broadcasting the feed, while feeding frequency of twice per day is adopted by majority (84%) of the farmers at interval of 8 hours a day. This study revealed that, farmers are economically active and educated; therefore adoption of best feed and feeding practices were high over a period of time even though most farmers had no formal training on fish farming.
Key word: socio-economics, feed, feeding practices, New Bussa and Niger State

Introduction
Over the past decade, Nigeria aquaculture production is rapidly growing at a fast rate, attracting investment, contributing to domestic fish food security, creating wealth, generating employment and jobs for the youths and women across aquaculture value chain(Ifejike, 2012 and 2013).Thus fish feed and feeding practices remain the limiting factors for the expansion of aquaculture in Nigeria(Farhat 2011).Majority of the farmers in Nigeria had not break even due to inadequate fish feed, high cost feed and poor feeding practices(Tobor et. al., 1985 and Aghoghovwia and Ohimain 2015). According to Ajani *et. al.,* (2015) optimal feeding practices especially for African catfish is yet to be clearly defined and this has led to uncertainty in the feeding routine used by many farmers. Both over and under feeding can be detrimental to the health of fish and may cause a marked deterioration in water quality, reduced weight, poor food utilization and increased susceptibility to infection (Priestley et.al., 2006). However, fish farmers most used the right feed at suitable feeding frequency, time interval and adopting the right feeding rate and method to avoid wastage during feeding. More so, this is expected to improved survival, feed intake and growth performance in fish culture(Schnaittacher et. al.,2005 and Ali et. al., 2005). The socio-economic characteristics pertaining to demography, mean of production and investment,

income and expenditure pattern of people livening a particular location strongly influence their responses to technological changes and participation in development (Pandey and Upadhayay, 2012). Therefore, this study aims at assessing the socio-economic profile, feed and feeding practices in the study area as this will provide information on level fish feed management adoption for efficient fish production.

Materials and Methods

The study was carried out at New Bussa metropolitan, Niger State, Nigeria located on latitude $9^0$53'N,$4^0$31'E and Longitude 9.833N, 4.517^{0}E with land area of 11,782.5(square km) and population of 171,965 National Population Commission (2006). Purposive sampling was use to obtained primary data from respondent through structured questionnaire, interview of farmers, while secondary data was obtained from journals, books, and the internet. A sample of 120 farmers was randomly selected for the study. Data analysis was carried out using descriptive statistics.

Results and Discussion

Data obtained from the study on socio-economic characteristics of the respondent is presented in table 1 and fish feed and feeding practices of the farmers in the study area is showed in Table 2.

Table 1: Percentage distribution of the Socio economic characteristics of respondents

Parameter	No. of respondents	% of respondents
Age(years)		
21-30	14	28
31-40	24	48
41-50	9	18
Above 50	3	6
Marital status		
Single	9	18
Married	36	72
Divorced	2	4
Others	3	6
Gender		
Male	42	84
Female	8	16
Family size		
Husband and wife	6	12
3- 4	31	62
5-8	10	20
9 and above	3	6
Level of education		
Non formal	5	10
Primary	3	6
Secondary	24	48
Tertiary	18	36
Farming experience		
1-5	32	64
6-10	15	30
>10	3	6
Mode of operation		
Full time	32	64
Part time	18	36
Formal training on fish farming		
Yes	12	24
No	38	76
Total	**50**	**100**

Table 2: Percentage distribution of fish feed and feeding practices of the farmers

Parameters	Frequency	Percentage (%)
Species of fish		
Clarias gariepinus	6	12
Heteroclarias (Hybrid)	28	56
Both species	16	32
Culture facilities		
Earthen pond	45	90
Concrete	3	6
Earthen and concrete	2	4
Types of feeds		
Floating feed	0	0
Sinking local pellet	0	0
Both floating and sinking feed	50	100
Reason for choice of feed		
Readily available	8	16
Low cost of sinking pellet	18	36
Better body weight	24	48
Diet formulate		
Self formulation	36	72
Fisheries expert	8	16
Fish Feed miller	6	12
Feeding method		
Base on body weight	4	8
Feed to satiation	43	86
Depending on feed availability	3	6
Feeding frequency		
Once a day	0	0
Twice a day	42	84
Three time a day	8	16
Feeding interval		
4 hours	0	0
6 hours	17	34
8 hours	33	66
Total	50	100

Socio-economic characteristics

Age of majority of the respondent (94%) were within the working population age group 21-60 while 48% of the respondents were within age group considered as economically productive age which portend better future for catfish production in the study area (Olowosegun *et.al*., 2005) . This is because fish farming requires adequate attention and a lot of sense of responsibility and also this implies that farmers were young, they are more inclined to adopt innovations (Baloronduro *et.al*., 2007). Marital status indicated that predominantly 72% were married while very few were single, widowed and separated. Gender of respondent in the study area shows majority (84%) of the fish farmers was male while 16% were female. This result can be justified by the assertion of Brummett *et al.,* (2010) that fisheries activities are mostly dominated by men and Akinrotimi *et. al*., (2011) reported that married men are more inclined to adopt new fish farming skills and practices as a result of their maturity, endurance and patience. The distribution of family size indicated that the house size of 3-4 is the highest (62%). Level of education of respondents without formal education was 10% while secondary education was 48% and tertiary 36%. This implies that, fish farming is dominated by the educated class in study area. This is so because fish farming requires a lot of technical and scientific knowledge to be successfully undertaken (Olaoye *et.al.,*2013). The years of experience of the farmers is relatively high (1-5years; 65%, 6-10 years; 30% and above 10 years; 6%). Nwachukwu and Anuegbu (2007) reported that, years of experience enhance farmer's level of participation in fish farming activities and acquiring new skills. Olaoye *et. al* (2013) reported that, farmers with longer years of experience should have good skills, better approaches to fish farming business and also able to forecast market situation in which their product will command higher price, while those with less years of experience face more risk in the early days of their fish farming business. Majority (64%) of the farmers operate on full time and 36% on part time basis. The study area indicated that 76% of the farmers has no form of formal training on fish farming business. This is similar to the finding of Sarker *et.al.*, (2006) who reported that, lack of training was among the potential obstacles facing fish farmers and Aghoghovwia and Ohimain (20015) also noted lack of training has serious negative consequence on improving competency due to poor knowledge and skills.

Feed and Feeding Practices
Majority (56%) of fish farmers in the study area prefer culturing of hybrid catfish (Heteroclaria) compared to the common Africa catfish (*Clarias gariepinus*) (12%) . Earthen pond (90%) was mostly preferred among the farmers. This may due to cheap sources of land, underground water during raining season and River Niger during dry season. This is similar to finding of Olalekan *et. al.,* (2014) who compared earthen ponds and concrete tanks and Aghoghovwia and Ohimain, 2015.

Fish Feeds
Feed types is another concern for the fish farmer, the result in this study indicated that 100% of the farmers preferred both floating and sinking pellet for better yield and least cost of production, this may be due to cheap sources of feed ingredient and nature of the culture facilities adopted by the farmers in study area. This finding disagreed with finding of Aliu et.al.,(2016) who reported farmers preferred using more of floating feed compared to sinking feed. This may due culture facilities adopted by farmers in study area. Choice of feed adopted by farmers indicated by 48% is because of better body weight, 36% low cost sinking pellet and16% is readily available in line with Aliu et. al., (2016) who reported that majority of the farmers chose feed due to availability and low cost of local feed. Majority (72%) of farmers determined there formulation while only 16% consulted the fisheries experts for feed formulation.

Feeding practices
About 86% of farmers in study area preferred to feed their fish to satiation by broadcasting the feed in the pond while 8% feed based on body weight. This may due to lack of formal training on fish farming by the respondents. This is different from the finding of Aliu *et.al*., (2016) who reported that farmers preferred to feed base on body weight. Feed frequency is the number times fish in a pond are fed daily, the frequency is important in order to reduce starvation, cannibalism and have uniform growth. The result of this study indicated that, majority (84%) of fish farmers preferred to feed their fish twice daily while 66% of the farmers feed at interval of 8 hours. This is similar to the findings of Maralikrishan *et. al*., (2010) and Ajani *et. al*., (2010) who reported that feeding of *clarias gariepinus* fingerling is the best feeding frequency in their separate studies.

Conclusion
This study revealed that, farmers are economically active and well educated, therefore adoption of best feed and feeding practices was high over a period of time. Commonly practiced is the use of earthen pond, culture of hybrid catfish and both floating and sinking pellet even though most farmers had no formal training on fish farming.

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Comparative Studies on Growth and Survival of *Clarias gariepinus* Fry Fed Decapsulated Artemia, Coppens granules and Dry Crayfish Meal

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Abstract
The growth and survival of Clarias gariepinus fry fed decapsulated artemia, coppens granules and crayfish meal as starter diet were studied. Fifty (three days old) fry 0.02cm and 0.03g average length and weight were stocked in each plastic bowl of 30 litres capacity. Each experimental diet was fed to the fry stocked in bowls arranged in four replicates in a completely randomized design. The results indicate that treatment I had the highest (45.5 ± 3.86) survival rate and statistically similar to II (41.0 ± 6.21) while treatment III (1.50 ± 0.50) was lower significantly (p>0.05). The results of growth rate showed that treatment II had the highest (0.5 ± 0.03) weight gain and significantly higher (p<0.05) than treatment III (0.24 ± 0.50), but statistically similar to treatment I (0.53 ± 0.23). Percentage weight gain and specific growth rate followed the same trend. The condition factor (0.92 ± 0.17) was best in treatment I with no significant difference (p>0.05) to other treatments. The entire results indicate that in the absence of Artemia, coppens can be used as first feed to fry, while crayfish meal should be discouraged.
Keywords: Artemia, Coppens, Crayfish, Diet, Survival and Growth

Introduction
Aquaculture is one of the fastest food growing sector, contributing 316,727Mt to domestic production of 1.027m Mt in 2015. However average annual demand for fish in Nigeria was estimated to be 3.25 million metric tonnes in 2015. (FDF, 2015) a deficit yet to be met. African Catfish (*Clarias gariepinus)* is popular specie for aquaculture in Nigeria where survival of its hatchery produced larvae still poses a major problem to aquaculture growth. Nigeria current total fingerling supply from all sources is 80.7 million in 2015 (FDF 2015). Fingerling production and availability of quality fish feeds have been the bane of fish farming development in Nigeria for the past four decades. Other authors, such as Abayomi *et al.*, (2010), Adebayo and Popoola (2008) also identified lack of quality fish seeds as the major constraint of fish farming and stressed the need for increased production of fingerlings to meet ever rising fish demand. Although, there had been a lot of research work on the production of catfish fry feed and feeding and the use of cheaper feedstuffs to replace imported feeds, but catfish farmers still rely mostly on the costly imported artemia. According to Olurin *et.,al*. (2012), larval fish nutrition in aquaculture is predominantly dependent on the use of brine shrimp artemia (*Artemia spp.*), particularly for the first feedings. However, the cost of brine shrimp is prohibitive for resource-poor farmers in the developing world and this has necessitated the investigation into alternative feeds. This study aims mainly to compare the growth and survival of *Clarias gariepinus* fry fed decapsulated artemia, coppens granules and dry crayfish meal.

Materials and Methods
Experimental Site: The study was conducted at the Fisheries and aquaculture department Hatchery complex, Usmanu Danfodiyo University (UDUS), Sokoto State, Nigeria. Located on latitude 13^{0} 07’ 78”N, and longitude 05^{0} 12’ 25”E at 275m above sea level (Google Earth, 20011).

Annual rainfall ranges between 500 to 724mm, while the mean relative humidity is 14.9% and 40% in March and June, respectively (Mamman, 2000).

Experimental Diets

Diet 1: Decapsulated (shell free) *Artemia,* The feed is manufactured by Inve Aquaculture, Inve (Belgium) Ltd.

Diet 2: Coppens, the Catco Fish Concentrate (0.3– 0.5mm) is produced by Coppens International GmbH, Nettetal Germany.

Diet 3: Crayfish meal**,** the crayfish was purchased as a whole crayfish, oven dry and grinded in the laboratory.

Table 1: Proximate Composition of the Experimental Diets

Diet composition	Decapsulated Artemia	Coppen granules	Crayfish meal
Crude protein	54%	56%	19.95%
Lipid	9%	9%	1.5%
Ash	4%	8.9%	18%
Fibre	6%	0.6%	2%
Moisture Content	5%	5%	0.5%

Experimental Fish

Free swimming fry of three day old were obtained from Fisheries and Aquaculture department hatchery UDUS. The initial total weight and total length were measured using JT210N Electronic Top loading weighing balance and a plastic ruler (30cm) length. The fry were siphoned in a bowl and were counted directly using a plastic strainer and transferred into the each experiment unit.

Experimental Design

The experiment was design as three (3) treatments and replicated 4 times in a completely randomized design (CRD). Twelve plastic bowls (30litres water capacity) were used. Each experimental unit was stocked with 50 fry (3 days old). Each bowl was filled with water up to 20 litres capacity. Stocking Density of 25 fry/m^2 was used for optimum growth and survival according to Sahoo *et al.*, (2010). Aeration was accomplished using Resun Air Pump (Model ACO-008).

Feeding

Feeding was done to satiation level in each experimental unit. Daily feeding frequency was four time between the hour of: 8:00-9:00am, 1:00-2:00pm, 4:00-5:00pm and 8:00-9:00pm. Uneaten feed were usually siphoned-out before each feeding. About 60 to 70% water renewal was made every morning and the bowls carefully mopped with soft foam in order to remove dirt from the medium. Complete water renewal and washing of bowls were done weekly.

Monitoring of Growth and Survival:

Daily mortality rates were monitored; total weight and total length of fry were measured weekly using JT210N Electronic Top loading weighing balance and a plastic ruler (30cm) length respectively. Growth parameter and survival data were calculated using the following formula:

Survival Rate

$$\text{Survival Rate (\%)} = \frac{\text{Ni-Nf} \times 100}{\text{Ni}}$$ (Akinwande *et al.*, 2012)

Where Ni = initial number of fish stocked, Nf = final number of fish at the end of the experiment.

Growth Parameters

Weight Gain (WG);

The weight gain recorded was computed according to Sveier *et al.* (2000).

(WG) = Final weight (g) – Initial weight (g)

Percentage Weight gain (PWG);

This was calculated as follows:

$$\text{PWG} = \frac{\text{Final mean weight(g)} - \text{Initial mean weight(g)}}{\text{Initial body weight}} \times 100$$

Specific Growth Rate (SGR);

This was calculated according to Castell and Tiews, (1980).

$$\text{SGR (\%)} = \frac{\text{LogeWf} - \text{LogeWi}}{\text{Time (days)}} \times 100$$

Where; Loge = Natural logarithm
Wi = initial weight (g) of fish at the beginning of the experiment.
Wf = final weight of fish at the end of the experiment.

Condition Factor (K)
Condition Factor (K) of fish fry in each experimental unit was calculated at the end of experiment adopting the procedure of Bagenal and Tesch (1987).

$$K = \frac{100w}{L3} \times 100$$

Where; W = weight gain of fish (g) L= total length of fish (cm)

Water Quality Parameter
In this study, only the temperature parameter was measured. The temperature was measured in the morning, afternoon and evening, using Mercury in Glass Thermometer.

Statistical Analysis
Data collected on growth and survival was subjected to analysis of variance (ANOVA), and mean were separated using New Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984). The analysis was carried out using the SPSS: 20.0 (2013) package for windows.

Results and Discussion

Survival Rate
The result in Table 2, showed that the percentage survival in treatments I (Artemia fed fry) 45.5 + 3.86, and II (Coppens fed fry) 41.0 ± 6.21 were not significantly different statistically (P>0.05). Lower percent survival was observed in treatment III (Crayfish fed fry) 1.50 ± 0.50 and was significantly (P<0.05) lower than the other treatments but numerically the highest survival rate was recorded in treatment I.

Growth Rate
The result of the growth parameters (Table 1) indicates that treatment II (Coppens fed fry) recorded the highest weight gain 0.54 ± 0.03 and was significantly higher (P<0.05) than treatment III (Crayfish fed fry) and was statistically similar (P>0.05) to treatment I (0.53 ± 0.025). Similar trend was observed in the percentage weight gain of the three treatments.
Treatment II has the highest specific growth rate (SGR) 16.14 + 0.05 and was significantly higher (P<0.05) than treatment III but statistically similar to treatment I (16.11 ±0.05).

Condition Factor
Condition factor as presented in Table 1 showed that treatment III (Crayfish fed fry) recorded the highest value 3.94 ± 2.43, followed by treatment II (Coppens fed fry) 1.34 ± 0.48 and treatment I had the lowest value (0.92 ± 0.17), and the result showed that there was no significant different among the treatments.

Water Quality Analysis
The water temperatures during the experiment. The morning, afternoon, and evening temperatures varied between 27⁰C to 30⁰C, 28⁰C to 31.5⁰C, and 27⁰C to 31⁰C respectively. The overall mean temperature values for morning, afternoon and evening were shown in Table 2.

Table 2: Summary of growth performance and survival of fry at the end of feeding with Decapsulated Artemia, Coppens granules and Crayfish meal

Parameters	Diet 1	Diet 2	Diet 3
Total number of fry	200	200	200
Total final number	91	82	3
Survival rate (%)	$45.5{\pm}3.86^{a}$	$41.0{\pm}6.21^{a}$	$1.50{\pm}0.50^{b}$
Mean weight gain (g)	$0.53{\pm}0.23^{a}$	$0.54{\pm}0.03^{a}$	$0.24{\pm}0.50^{b}$
Mean percentage weight gain (%)	$1763.89{\pm}84.84^{a}$	$1811.93{\pm}100.20^{a}$	$1788.8{\pm}400.62^{b}$
Mean specific growth rate	$16.11{\pm}0.05^{a}$	$16.14{\pm}0.05^{a}$	$15.16{\pm}0.47^{b}$
Final body length (cm)	$4.03{\pm}0.27^{a}$	$3.90{\pm}0.57^{a}$	$1.50{\pm}0.50^{b}$
Condition factor	0.92±0.17	1.34±0.48	3.94±2.34

Table 3: Average Water Quality values during the experiment

Temperature	Morning	Afternoon	Evening
Minimum	27.00	28.00	27.00
Maximum	30.50	31.50	31.00
Mean (±SE)	28.70±0.73	29.80±0.64	29.20±0.72

The result on survival rate showed that treatment I and II differed from III, where the lowest survival rate (35.9 ± 4.23) was obtained. Treatment I (Decapsulated Artemia) had the highest survival rate (45.5 ± 3.86) and treatment I and II are statistically similar .This observation agreed with findings of Sorgeloos *et al.,* 2001; Olurin *et al.,* 2012, that Artemia reduces mortality thereby increasing survival rates of fish. This could be attributed to the fact that Artemia did not pollute the water, the water remained clear throughout the period of the experiment, indicating good utilization of the diet by the fry as against cloudy water in crayfish meal experimental units due to uneaten feed and water with oil films as observed in treatment fed coppens granules. Furthermore, In terms of growth performance, treatment II was higher than I. This differed from the study of some scholars (Achionye *et al.,* 2012), (Verreth and DenBiema, 1987), where fry fed Artemia had the highest growth rate i.e. SGR for Artemia was 12.56 per day compare to commercial diets with 2.98 per day. This could be attributed to the fact that treatment II had highest crude protein content (Table 1) which causes the fry to grow faster than treatment I. Treatment III had the lowest crude protein and consequently could result in lowest growth recorded. The lower growth rate and survival rate recorded in treatment III might be due to poor crude protein 19.95% compared to that of treatment I (54%) and treatment II (56%). The general high mortality recorded in this experiment could be attributed to handling from weekly sampling stress, since the fry were fragile to handle. The weight gain, percent weight gain and specific growth rate in this study showed that treatment I and II were similar, with treatment II having the highest values. While treatment III is significantly lower from I and II. The growth variation observed in this study however could be attributed to the nutrient composition of the diets (Kiriratnikom and Kiriratnikom, 2012). The condition factor was highest in treatment III, followed by treatment II and lowest in treatment I. Thus, treatment I, which had the lowest condition factor, had a better wellbeing (Viveen *et al*., 1986), which could be as a result of the low survival rate recorded in treatment three and lack of sorting to take out the outgrown fry from the culture media making the few fry remaining attain higher weight. The mean water temperature recorded during this period was within the temperature (25°C-32°C) range as recommended by Boyd and LitchoKopler (1979). The relative fluctuation of minimum and maximum morning, afternoon and evening temperature could also have influenced poor survival recorded in this experiment.

Conclusion

The study showed that survival rate was high in treatment I, While specific growth rate was higher in treatment II but not significantly different. However, both survival rate and growth rate were low in treatment III. It was concluded that Decapsulated Artemia did not pollute the water and maintained water transparency thereby increasing the survival. It was observed most time that after feeding with coppens, and Crayfish meal, the culture medium became cloudy and this result to odour in the culture medium, hence increasing mortality of the fry subjected to the two treatments. This study revealed that, when considering the wellbeing of fish fry, Decapsulated artemia proofed the best, followed by coppens which can be used as alternative to Artemia however crayfish meal was not suitable for feeding fry

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Current Status of Aquaculture Management Practices in Lagos State

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Abstract
Due to low supply of fish from artisanal fisheries and high demand for animal protein food, there is serious intensification of aquaculture in Lagos State. A survey was carried out between February and May 2018 in 60 randomly selected fish farms, out of 300 existing fish farms in Lagos State to determine the personnel structure of farm owners and evaluate the farm management practices in the area. A questionnaire was designed and face-validated by experts with recording an overall reliability coefficient of 0.87%. Stratified random sampling technique was used to select the farms and data were collected from on-going farm operations. Most farm owners (80%) were male, majority (67.1%) fall between 41-50 years, more were educated (60 %), higher percentage (51.7%) were part-time farmers. 75% of the farms were monoculture of catfish species using stagnant earthen pond (23 %) and flow-through concrete tanks (16%) in semi-intensive level of production. Mostly (66.7 %) applied two production cycles per annum, most farmers (35 %) produce 30-40 tons of fish per annum. In management practices; 60 % apply high stocking density, 80 % of these farmers use earthen ponds at zero water renewal and high percentage of the farmers (70 %) feed twice a day. In conclusion the study established ineffective farm management practices, non-uniformity and non-compliance of the existing standards in fish farms in Lagos State and advocates for more in-service training and enforcement of the existing protocols in fish production.

Introduction
Management practices in aquaculture are routine farm operations that are carried out during fish production. The major management practices necessary for effective production are; water quality control, stocking, feeding, treatment of diseases, transportation, harvesting and record keeping. These practices aim at enhancing fish production but their procedures if not properly carried out could be detrimental to fish health (Gabriel *et al*. 2010). Management and practices differ among different types of aquaculture systems; pond culture, flow-through systems and recirculating systems, however, all production systems share the same environmental concerns: water use and discharge, land use, waste discharge, and the prevention of introduction and spread of invasive species and disease (Craig *et al*. 2006), therefore good practices are intended to assist growers in improving production and health status while minimizing stress. Best Management Practices (BMP) has a number of uses. They can guide those starting aquaculture projects, expanding or updating facilities, or growers maintaining present operations. Stocking marks the beginning of production cycle. Stocking density of any aquaculture media has to be considered first in management principles. This is because if a medium exceeds its carrying capacity, fish stress is bound to occur which can eventually lead to fish mortalities (Sirakov and Ivancheva, 2008). The process of stocking referred to here, starts with the collection of fingerlings from the hatchery, transporting them to the farm and, finally, putting them in either pond or tank. Poor stocking procedures, are among the major causes of low survival in grow-out systems (Nelly et al., 2009). They result in stress, diseases and reduced growth and eventually lead to mortality and financial losses. Water quality is the second aspect to consider in aquaculture management. The failure or success of production lies on this key factor. Poor water quality at high level does not spare the life of the fish for a minute. Therefore, this has to be checked regularly as prescribed below. The basic water quality parameters that are important in maintaining fish health include: dissolved oxygen (>4.0 mg/L), salinity (15-32ppm), temperature (26-30°C), pH (6.5- 8.5), nitrogen compounds [ammonia (< 0.15 mg/L), nitrate and nitrite (< 4.5

mg/L)], BOD [5day (50/30 mg/L)], hydrogen sulphide (< 0.1mg/L) and pesticides. High productivity in aquaculture production only transpires when fish are healthy and free from diseases. Fish disease management is aimed at preventing the onset of disease and measures to reduce losses from disease when it occurs (Andrew, 2007). Records are kept from the onset of stocking to the harvesting period. They are valuable in health management. Accurate records of numbers and sizes of fingerlings, time, type and quantity of the feed fed, periods of water changed, time of aeration, date of treatment and vaccination are kept. These records will help in evaluation of the status of fish populations and provides a proper guide to next farming. The fast growing human population in Lagos State with the low supply of fish from artisanal fisheries in complementing high demand for animal protein food has led to intensification in aquaculture industry (FDF, 2015). Hitherto, there was no record of the dynamics of the emerging and existing fish farms in Lagos State. This gap has the potential of militating against the production of quality fish in sustainable aquaculture in Nigeria. This study will provide relevant information and knowledge-based guidance to extension workers and regulators in aquaculture industry in Lagos State. It will provide adequate information that will assist the government in formulating effective policies, enforcement of the implementation of existing regulations and good management practices in fish farms. This study suggests that growers use this manual to conduct audits of their facilities to determine where improvements can be made. Growers may use these guidelines to develop their own farm-specific standard operating procedure (SOP) manual.

Materials and Methods

This assessment took place between February and March 2018. Data for the study was generated through structured questionnaire titled “Characteristics and management practices in fish farms in Lagos State” was designed and validated by two experts in Education Department of the University of Lagos. Cronbach alpha was used for the reliability test and an overall reliability coefficient of 0.87 % was obtained. The questionnaire sought for socio-economic characteristics of the farms owners/managers such as gender, age, marital status, educational background and level of fish farming in section one while section two elicited responses on management practices applied in their farms such as stocking rate, water renewal and feeding regime. Stratified random sampling technique was employed to select sixty fish farms; three fish farms from twenty Local Government Areas in Lagos State.

Statistical Analysis

Descriptive analysis involving the use of measure of central tendency such as frequency, percentage and chats were used for the data (Ogbeibu, 2005)

Results and Discussion

Data obtained from socio-economic characteristic of the respondents during the study are shown in figure 1. It indicated that there were more male fish farmers in Lagos State constituting 80% of the respondents, while the female farmers were 20 %. Majority of the respondents 61% were within the economically active age group of 41-50 years. These finding in agreement with Rodda (1993) who reported that the average active age of 45 years, were expected to have gained enough experience on how to efficiently manage their farms. At this age also, their marginal physical productivity is on the increase. Result obtained from this study also indicated that 62% of the fish farmers were married. While 60 % of the respondents were literate with secondary school qualification, 32 % had tertiary education and 8 % had primary school qualification; 52 % were part-time farmers while 48 % operated as full-time business. These findings compared favourably with observation made by Aromolaran (2002) and Adewuyi *et al*, (2010).

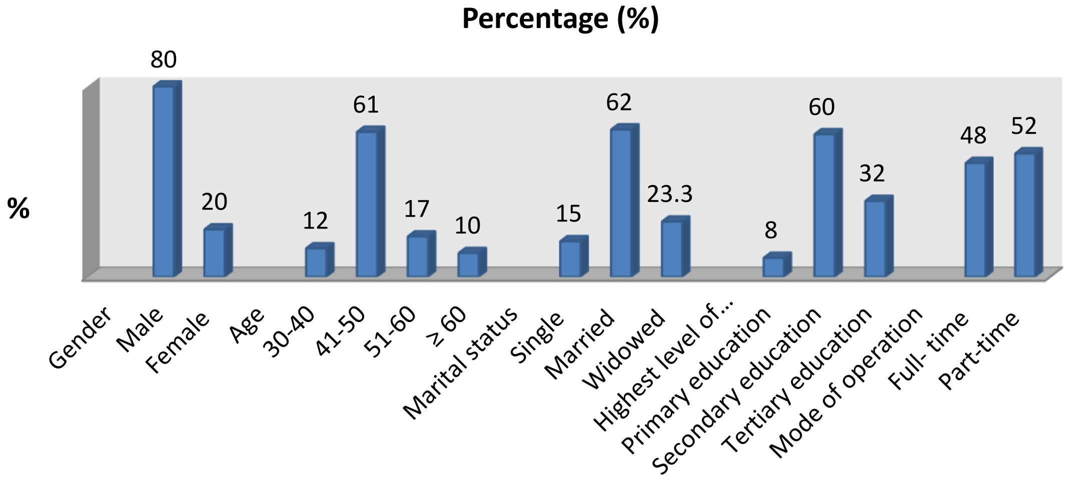

Figure 1: Socioeconomic characteristics of fish farmer/managers in Lagos State

Characteristics of fish farms in Lagos State were presented in Figure 2. Monoculture technique was found to be the most practiced culture technique in Lagos State. This might not be unconnected with less technicality involved in this system of culture, the findings of the research was similar to that of Adeogun *et al*. (2007) and Akinwole *et al* (2014). The most cultured species of fish in the study area was African catfish, *Clarias gariepinus*, the result was similar to that of Akinwole *et al*. (2014) and Adeogun *et al* (2007). This could be attributed to ease of culture of catfish, availability of market and favourable weather condition. This production amount therefore confirmed the position of Dauda *et al*. (2015) who noted that the reported increase in fish production in Nigeria (FAO, 2012) was not evenly distributed and more dependent on southern part of Nigeria. Aquaculture had been successfully practiced in different holding structures. In Lagos State Nigeria, aquaculture was practiced in different holding structures including earthen ponds, concrete tanks, plastic tanks, fiberglass tanks, as well as collapsible tanks; however, concrete tanks and earthen ponds were the most commonly used culture facilities. The result of this research in agreement with Adeogun *et al*. (2007); Akinwole and Akinnoye (2012), who opined that earthen pond and concrete tanks remained the most commonly used culture facility in Nigeria. According to them, the choice of culture facility might be influenced by availability of space, mode of operation and finance among other objectives.

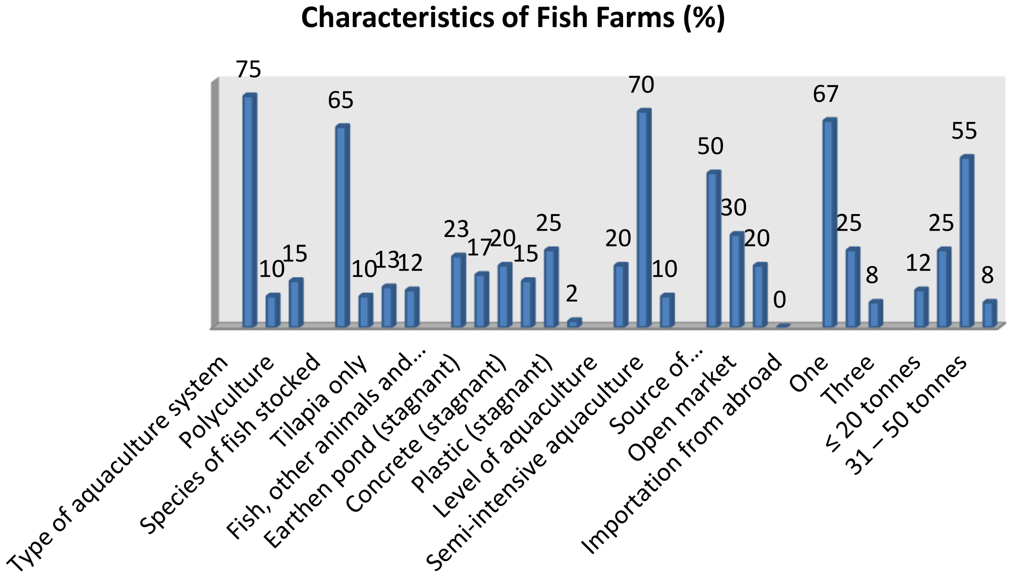

Figure 2: Characteristics of Fish Farms in Lagos State

Table 1 shows the management practices in Lagos fish farms. Water quality management has impacts on success of aquaculture venture (Omitoyin, 2007). Management of water quality was very poor in some of the studied farms as water renewal was not frequent in some concrete tanks while zero water exchange was operated by most of the earthen ponds. This water management system is not safe for the fish and could affect the health status (Akinwole and Adeola, 2012). The problem of water quality was among the factors responsible for poor growth performance in the farms. This is in line with the position of Dauda *et al.* (2015) who stated that poor water quality have adverse effect on the growth and well-being of cultured fish species. Higher stocking densities have been reported to have aggravated stress that resulted in reduced feeding and specific growth rate (Yousif, 2002); furthermore, high stocking densities and zero water exchange resulted to reduced specific growth rates in GIFT Tilapia Juveniles (*Oreochromis niloticus*) reared in tanks in China (Kpundeh, 2013). Varied stocking densities and zero culture water exchange rate in this study, resulted to lower specific growth and high mortality rates respectively. High density of fish may have suffered from weakened immunity that resulted to their death. Feeding is an important management practice in fish production. It has direct impact on growth performance (Biswas et al., 2006). This research finding showed that most of the farmers in the study area fed their fish twice a day which makes it difficult for fish to grow optimally (Dasuki et al., 2014). The type of harvesting system in the study area was similar to that reported by Adeogun et al. (2007), where most of the farmers harvested their fish partially and sold at farm gate.

Table 1: Management practices in Sixty Randomly Selected Fish Farms in Lagaos State

Farm Management Practices	Frequency	Percentage
Stocking density		
Overstocking	36	60
Under stocking	12	20
Standard stocking	12	20
Water renewal (in Tanks)		
Once per week	15	25
Twice per week	38	63
Thrice per week	7	12
Water renewal (in ponds)		
Once per month	12	20
Zero water exchange	48	80
Feeding regime		
Once per day	12	20
Twice per day	42	70
Thrice per day	6	10

Conclusion

The low fish yield could be attributed to poor management practices, due to non-implementation of aquaculture standards or ignorance among the fish farmers. Therefore the study recommends in-service training and enforcement of the existing protocols for fish production in all farms.

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Abstract
The length-weight relationship and condition factor of Sphyraena afra from off Lagos coast (LC) and Lagos lagoon complex (LLC) in coastal waters ~~of Lagos State was studied~~ for a period of two years. The total length and weight were measured using standard methods. The parameter 'a' and 'b' of the length - weight relationship were estimated using the equation $W= al^b$ while the condition factor was also calculated for the equation $K= 100W/L^b$. The relationships of the fish's condition factor and body length, sexes and seasons in coastal waters of Lagos were determined. The species exhibited negative allometric growth ($b< 3$, $p<0.05$) for males, females and combined sexes with length exponent (b) ranging from 2.72 to 2.85. The coefficient of determination (r^2) for length-weight relationship of the species in all the station was very high (0.89 to 0.95) and correlation coefficient 'r' ranged from 0.94 to 0.97. The allometric growth values obtained in LC and LLC from length - weight relationship were indication that the fish species exhibited increase in length than mass. The overall mean condition factors (K) for Sphyraena afra in Lagos coast and Lagos lagoon complex were 1.16 ±0.13 and 0.97±0.12 respectively. The mean condition factors of female were higher than male in most of the sampling stations. Sphyraena afra was observed to be in better condition during the dry season.

Keywords: Sphyraena afra, condition factor, length-weight relationship and correlation coefficient

Introduction
Barracudas are commercial species of the Sphyraenidae Family occurring in tropical and subtropical oceans. Sphyraenidae includes only one genus, *Sphyraena* with 21 species (Nelson 2006). Four species of the genus *Sphyraena* encountered were collected from the coastal waters of Lagos state and identified as *Sphyraena afra, Sphyraena guachancho, Sphyraena barracuda* and *Sphyraena sphyraena* using FAO guides (Carpenter and De Angelia's 2016). *Sphyraena afra* is the most abundant and commonly seen in both the estuaries and marine water. The fish commands high market value and high consumer acceptability as the fish is tasty and firm. *Sphyraena afra* is a candidate for marine culture and information of the length-weight data of this fish is important for the development of successful management program in the wild and culture in the coastal waters of Lagos state. Information about the individual body length-weight relationships in population characteristics is in general of great importance for estimating the population size of a stock for the purpose of its exploitation (Atar and Secer 2003). Length-weight regressions have been used frequently to estimate weight from length because direct weight measurements can be time-consuming in the field (Sinovcic et al. 2004). Length – weight studies on fish are extensive in Nigeria. Notable among these are the reports of *Tilapia guineensis* in Elechi creek, PortHacourt (Diri 2002). Ayoade and Ikulala (2007) for *Hemichromis bimaculatus*, *Sarotherodon melanotheron* and *Chromidotilapia guentheri* in Eleyele Lake Southwestern Nigeria. Abowei et al. 2009 studied the Length–Weight Relationship and Condition Factor of Five Fish Species from Nkoro River, Niger Delta, Nigeria. Lawson (2011) for the Mudskipper *Periophthalmus papilio* in Lagos Lagoon. The condition factor expresses the condition of a fish, such as the degree of well-being, relative robustness, plumpness or fatness in numerical terms and is based on the hypothesis that heavier

fish of a given length are in better condition (Bagenal and Tesch 1978). Gallardo-Cabello et al. 2007 reported that the condition of fish diminished when the food availability in one area decreased. Some condition factors reported for fish species include; *Mugil cephalus* in Bonny estuary (Hart 1997), four cichlids species of a man - made lake in Imo state (Anene 2005), *Clarotes lateceps* from the fresh water reaches of the lower Nun river (Abowei and Davies 2009), *Liza falcipinnis* from Badagry creek Lagos (Lawson et al. 2010), Adeyemi (2011) for *Synodontis robbianus* at Idah area of River Niger, Kogi state. Length-weight relationship of marine fish resources in Nigeria are limited and the present contribution is aimed at compensating for this and due to high demand for this species in the country.

Materials and Methods

Study Area

The study area covered coastal waters of Lagos State from Yovoyan in Badagry to Lekki Lagoon. 7 stations were selected along the coastal waters: 3 stations from Lagos lagoon complex (Lagos lagoon, Lekki and Badagry lagoon) and 4 stations from off Lagos coast (Yovoyan, Ibeshe, Oshoroko and Orimedu). The stations were selected to cover both the marine and brackish water of different salinity gradients which bordered on the West by the republic of Benin and in the south stretches for 200km, along the coast of the Atlantic Ocean. The study area is located between longitude 2º 45´and 3º 60´ and latitude 6º 20´and 6º 34´ (Fig.1). Sampling stations included fishing villages and landing sites in the study area. The Lagoon coastal complex stretches from Badagry to around Agerige village where the coastline starts a southward inflection. The climate is typical of rainforest/ tropical coastal waters with prolonged wet season (April - October) and short dry season (November - March) (Awosika et al. 2001). The fringes of the Lagos coastal water are mainly colonised by white mangrove *Avicennia* and red Mangrove trees (*Rhizophora* sp.), On the southern edges much closer to the sea, coconut (*Cocos nucifera)* and giants reeds, mainly *Paspalum vaginatum* and *Spore bolus virginucus* form most of the vegetation.

Collection of specimens

Monthly sampling was carried out from four stations (Yovoyan, Ibeshe, Orimedu and Oshoroko) off Lagos Coast and three stations from Lagos Lagoon Complex (Lekki, Lagos and Badagry lagoon) of Lagos state between 07.00 am and 10.00 am from August 2009 to July 2011. Surface water samples were collected with 500 ml plastic containers from all the stations. Parameters such as water temperature, salinity, water transparency and dissolved oxygen were measured in-situ with a mercury-in-glass thermometer calibrated from 0 ºC to 100 ºC validated with Jenway DO meter, hand refractometer (Biomarine, Aquafauna model), a Secchi disc and Jenway DO meter (Model 9071) respectively.

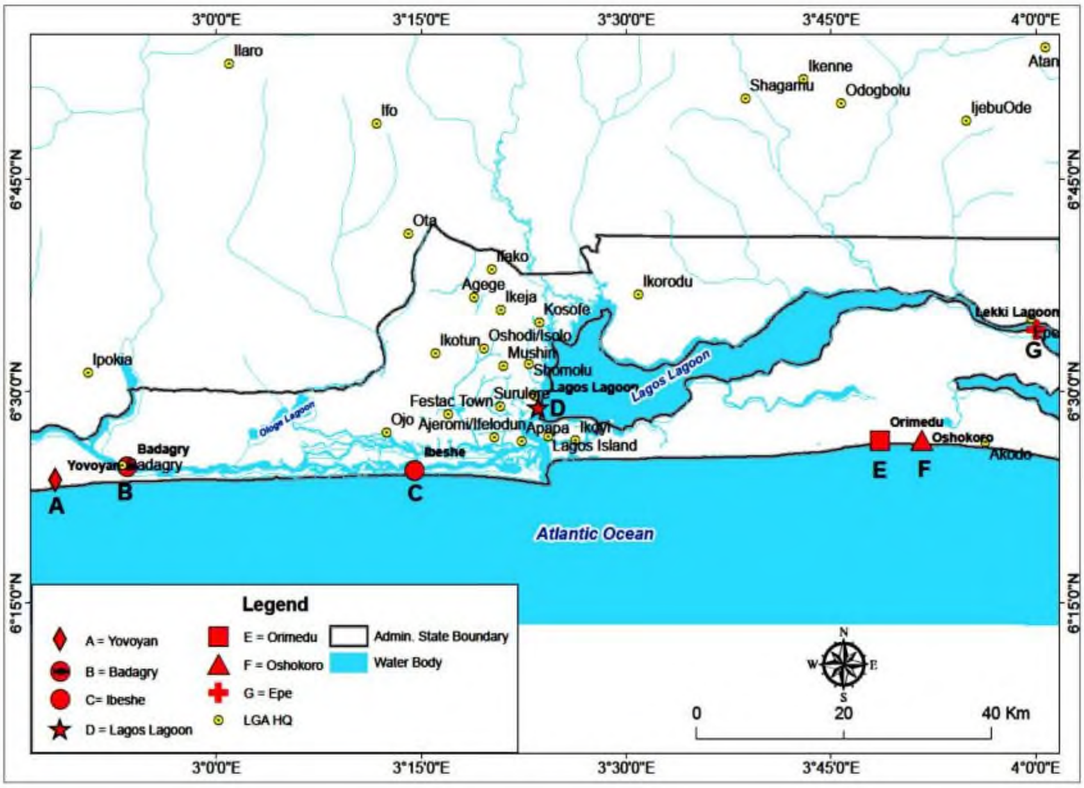

Figure 1: The map of coastal waters of Lagos state showing sampling stations.

Collection of specimens

A total of two thousand three hundred and fifty four specimens of *Sphyraena afra* (total length, 17.60 - 183.30 cm, total body weight, 27.2 - 25,000 g) were collected monthly for length-weight relationship and condition factor from August 2009 to July 2011 using a combination of fishing gears; including trawl nets, purse seines, gill nets, trammel nets and longlines with the help of fishermen. The mesh sizes of the net materials ranged from 2.5 – 6.0 inches depending on the sizes. Hook and lines were mainly used to catch large sized fish species. Fish specimens caught were transported in thermo cool boxes to the laboratory on each day of sampling. The species was identified with FAO guide.

Length and weight measurements

Total length and weight of fish specimens were measured to the nearest centimeter and grammes respectively to obtain data on the length-weight relationship. The length-weight relationship and condition factor of the fish specimen from Lagos coast (LC) and Lagos lagoon complex (LLC) were estimated using the exponential equation (Roff 1986)

$$W = aL^b. \tag{1}$$

Where, W=weight in grams, L= Total length in centimeters and 'a' and 'b' are regression constants. This relationship was transformed into a linear form by the equation.

$$\text{Log } W = \log a + b \log L. \tag{2}$$

Condition Factor

Fulton's condition factor (K) (Ricker 1975) to determine the well-being of the fish was calculated seasonally in all the stations. Calculations were made separately for both sexes
$K = 100W/L^3$
Where, K = condition factor, W = weight in grams, and L = Total length in centimeters.

Statistical Analysis
Data collected were collated and analysed using descriptive statistics (means and standard deviation). All the analysis were performed using IBM SPSS 20.0 software at P= 0.05 and P < 0.001 significance level. Analysis of covariance was used to compare the length –weight relationship between sexes, condition factors between sexes, seasons and length. The chi-square(X^2) test was used to determine if a population contains equal proportions of males and females. T-test was used to determine the level of significance of the parameters in the two water bodies.

Results and Discussion

Physicochemical Parameters
The surface water temperature ranged from 27.5±0.12 ºC to 30.7±0.08ºC during the study period. There was significant difference in the temperature between the dry and rainy season ($p< 0.05$) in the two environments (Table 1). The salinity of the coastal waters during the period of sampling ranged from 0.9±0.11‰ to 33.2±0.18‰. Off Lagos coast (LC) had higher salinity gradients than LLC and higher values were recorded during the rainy season (Table 1). There was significant difference in the temperature between the dry and rainy season ($p< 0.05$) in the two environments. The water transparency values ranged from 0.17±0.04m -0.51± 0.12m while the dissolved oxygen values ranged from 5.5±0.11mg/l to 7.5±0.13mg/l (Table1).

Length –Weight Relationship and Fulton's Condition Factors
Descriptive statistics and estimated parameters of length-weight relationship for *Sphyraena afra* from coastl waters of Lagos State is shown in Table 2. The species from LC and LLC exhibited negative allometric growth ($b< 3$, $p<0.05$) for males, females and combined sexes with length exponent ranging from 2.72 in Lagos coast to 2.85 in Lagos lagoon complex. The coefficient of determination (r^2) for length-weight relationship of the species in all the stations was very high (0.888 to 0.952) and correlation coefficient 'r' ranged from 0.94 to 0.98. The mean condition factor (K) for male, female and combined sexes were 1.15 ± 0.24, 1.19 ± 0.18 and 1.17 ± 0.11 for Lagos coast and 0.96± 0.13, 0.98 ± 0.24 and 0.97 ± 0.11 for Lagos lagoon complex respectively. The overall mean condition factor (K) for *Sphyraena afra* in LC and LLC were 1.16 ±0.13 and 0.97±0.12 respectively. Summary of the Length-weight equation of *Sphyraena afra* from coastal waters of Lagos State is represented in Table 3.

Table 1: Physiochemical parameters of the coastal waters of Lagos State

Parameters	**Mean values**			
	Off Lagos Coast (LC) (LLC)		**Lagos lagoon complex**	
	Rainy season	**Dry season**	**Rainy season**	**Dry season**
Temperature (^{0}C)	27.5±0.12	30.5±0.11	27.5±0.15	30.7±0.08
Salinity (‰)	27.1±0.06	33.2±0.18	0.9±0.11	7.2±0.03
Water transparency (M)	0.25±0.02	0.51±0.12	0.17±0.04	0.39±0.01
Dissolved oxygen (mg/l)	5.6±0.08	7.5±0.13	5.5±0.11	7.3±0.18

Table 2: Descriptive statistics and estimated parameters of length-weight relationship for *Sphyraena afra* from coastl waters of Lagos State

Location	n	Total body length (cm)		Total body weight (g)		Fulton condition factor		Regression parameters					
		Min	Max	Min	Max	Min	Max	*a*	95% Cl of a	*B*	95% Cl of b	SE (b)	r^2
Lagos lagoon complex													
Males	296	18.9	183.3	28.5	25,000	0.76	1.15	0.0088	0.009	2.75	0.04	0.076	0.94
Females	342	18.0	153.2	27.6	15,300	0.95	1.21	0.0092	0.013	2.85	0.12	0.059	0.95
Sum	638	18.0	183.3	27.6	25,000	0.76	1.17	0.0090	0.011	2.80	0.09	0.068	0.95
Lagos coast													
Males	820	17.6	116.9	27.2	6,305	0.89	1.18	0.01125	0.014	2.72	0.065	0.092	0.93
Females	896	18.4	154.4	27.3	15,300	0.93	1.21	0.01144	0.089	2.75	0.078	0.112	0.89
Sum	1716	17.6	154.4	27.2	15,300	0.89	1.20	0.01135	0.062	2.73	0.072	0.087	0.91

n, sample size; min., minimum; max, maximum; total lengths in cm; total weight in g; a and b, parameters of length- weight relationship; CL, confidence limits; SE (b), standard error of slope b; r^2, coefficient determination

Table 3: Summary of the Length-weight equation of *Sphyraena afra* from coastal waters of Lagos State

Location	n	Equation ($W = a L^b$)	r^2
Lagos lagoon complex	638	$W=0.0090L^{2.80}$	0.91
Lagos coast	1716	$W=0.01135L^{2.73}$	0.95

N, sample size; W, fish body weight; L, body length and r2, coefficient of determination

Length-weight relationship (LWR) is important for fish stock assessment. The correct interpretation of the parameters resulting from length-weight relationship will disclose information that is useful for fisheries management. A characteristic of length-weight relationship in fishes and invertebrates is that the value of the exponent b is 3 when growth is isometric (without changing shape). If b value is different from 3, growth is said to be allometric (fish changes shape as it grows larger). Allometric growth may be negative (b < 3) or positive (b > 3). Wootton (1998) indicated that allometric growth is negative (b < 3) if fish get relatively thinner as it grows larger and positive (b > 3) if it gets plumper as it grows. Statistical analysis of the length –weight data showed that *Sphyraena afra* male, female and combined sexes exhibited negative allometric growth in coastal waters of Lagos state, since the value of b (the exponential) of the regression equations representing their length- weight relationships were less than 3. The allometric growth values obtained in all the stations from length weight relationship were indication that the fish species exhibited increase in length than mass. These showed that even though there were corresponding increase in weight with increase in length, at certain stages of fish growth, increase in weight were no longer directly proportional to the increase in length as revealed in some fish species. The determined b value 2.72 to 2.85 for *Sphyraena afra* in this study is within the ranged of 2.5 to 3.49 reported for other barracuda species such as great barracuda, *Sphyraena barracuda* (Froese and Pauly 2005). Jaiswar et al. 2004 reported b value of 2.72 to 2.73 for *Sphyraena obtusata* in Bombay waters, West coast of India while b value of 2.84 to 2.89 was reported for the same species from the Jaffina Lagoon, Sri Lanka (Sivashanthini et al. 2009). Hosseini et al. (2009) also reported b value of 2.77 to 2.87 for *Sphyraena jello* from Persian Gulf. Some investigators reported that the slight differences in the b value could be due to variation in the environmental or ecological conditions of different habitats or variation in the physiology of the animal or both (Jaiswar and Kulkami 2002, Bhattacharya and Acharya, 1984). Ecological functions such as temperature, food supply, spawning conditions and other factors such as sex, age, fishing time and area and fishing vessels could also influence the value of b (King and Udo 1996). The observed differences in length weight relationship (LWR) of fish could be due to the quality and quantity of food available in one area or water body (Sparre and Venema 1992) and due to the male-female ratio. On the other hand, Schneider et al. (2000) described that the exact relationship between length and weight depends on their body shape and condition (robustness) of individual fish. Oniye et al. (2006) also reported that the weight of fishes increase when they utilize the food items available for growth and energy. Variations in a fish's coefficient of condition primarily reflect state of sexual maturity and degree of nourishment. Wootton (1998) reported fish species with high values of K are heavy for their length while low values of K are light for their length. The observed values of the condition factor of *S. afra* female higher than the male indicated that the females were healthier than the males. This could be attributed to the differences in gonad development. The highest K values are reached in species if the fish is fully mature and having higher reproductive potentiality (Ugwumba 1990 and Agboola et al*.* 2008). The overall mean condition factor (K) for *Sphyraena afra* of 1.16 ±0.13 and 0.97±0.12 obtained in off Lagos coast and Lagos lagoon complex respectively indicated better condition in LC than LLC and varied slightly with the result of other studies: Ajayi (1982) reported K value of 0.77- 0.81 for *Clarotes filamentosus* in Lake Ogonta; Nwaduaro and Okorie (1985) obtained K= 0.49-1.48 for *Chrychthys filamentosus* in Adoni River: Abowei *et al*., 2009 reported K value of 0.941 – 0.985 for five fish species in Nkoro River, Niger Delta, Nigeria. The value obtained showed that the fish specimens studied were in good condition in all the water bodies. *Sphyraena afra* was observed to be in better condition during the dry season.

Conclusion

In conclusion the LWR of *S. afra* revealed negative allometric growth in the two water bodies. The K value suggested that the condition of the coastal waters of Lagos state is favourable for the species. *Sphyraena afra* can survive off Lagos Coast (LC) and Lagos Lagoon Complex (LLC) and in good condition despite the differences in the salinity gradient of the two environments. High dissolved oxygen content indicated that the coastal water of Lagos state can successfully support aquatic life including fish. Values obtained for water temperatures in the coastal waters of Lagos state were within the acceptable levels for survival, metabolism and physiology of aquatic organism.

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Incidence and Antibiotic Susceptibility Pattern of *Vibrio fluvialis* Isolated from Fresh Shrimps Sold in Makoko Fish Market, Lagos

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Abstract
Vibrio fluvialis is an emerging food borne pathogen that is associated with the consumption of contaminated seafoods. Surveillance of the microbial susceptibility to the common antibiotics is very important. In this study, ninety (90) samples of fresh shrimps were randomly purchased from fish sellers in Makoko fish market. V. fluvialis was cultivated using standard bacteriological method on Thiosulphate Citrate Bile Sucrose agar (TCBS). The isolates were subjected to their susceptibility patterns using agar diffusion method. A total of sixteen (16) isolates were phenotypically identified as V. fluvialis. The isolates were more susceptible to ofloxacin, ciprofloxacin, gentamicin, nitrofurantoin, nalidixic acid and co-trimoxazole as compared to augmentin, ceftazidime, tetracycline and amoxicillin antibiotics. Isolation of V. fluvialis from the fresh shrimps is of public concern. There is need of regular surveillance on the use and abuse of antibiotics in Lagos and its environs.

Keywords: Vibrio fluvialis, antibiotics, Makoko and shrimp

Introduction
Vibrio species are Gram-negative, curved rod shaped, oxidase positive and non spore forming bacteria (Austin, 2010). They are naturally present in the marine environment, and are particularly resistant to high salt concentrations. A number of species within the genus *Vibrio* are associated with food borne infections and food spoilage. About twelve (12) species are pathogenic to human while eight (8) are associated with food borne illness (Dickinson et al., 2013). The majority of the food- borne illness is caused by *V. fluvialis, V. parahaemolyticus, V. vulnificus* and *V. cholera.* The immune suppressed individuals are the most susceptible to other *Vibrio* infections (Miyoshi, 2013). Seafood constitute an important food component for a large section of world population (Lutz *et al*., 2013).The rise in seafood consumption and the global warming, resulting in increased ocean surface temperatures, may cause higher prevalence of *Vibrio* species, and increase the risk of *Vibrio* food borne infections (Hassan *et al*., 2012). *Vibrio* food-borne illnesses have been reported in Asia and Africa regions (McLaughlin *et al*., 2005). Utsalo *et al*. (1992) also reported *Vibrio* infection in Calabar Nigeria. However, there is significant number of reports on food borne infections from the consumption of raw fish or improperly cooked contaminated fish and shellfish (Oyster, Clams, Mussels, Crabs, Shrimps, periwinkles and prawns) (Eja *et al*., 2008; Lutz *et al*., 2013). *V. fluvialis* is one of the emerging food borne pathogen all over the world. The distribution of virulence factors and antibiotic susceptibility pattern of this pathogen remain mostly unknown. Among the food borne infections in the United States, there has been a significant increase (43%) in the *Vibrio* mediated infections since 2012 compared with the rates reported 2006-2008 (center for disease control and prevention CDC, 2013). There is no proper documentation, assessment of non- cholera *Vibrio* species from seafood in Lagos State and there is dearth of information on incidence of *V. fluvialis* and the antibiotic susceptibility. This study would provide information on the incidence of *V. fluvialis* its antibiotic susceptibility. The study was conducted to monitor the incidence and antibiotic susceptibility pattern of *Vibrio fluvialis* from fresh shrimps sold in Makoko fish market in Lagos.

Materials and Methods

Sample collection, cultivation and identification of *V. fluvialis*

Description of collection site

This market were chosen because it was identified as an important secondary fish market in Lagos State and it plays a very critical role in selling fishery products to the citizens of Lagos Metropolis. The market operate as daily market and opens as early as 6.00 am for sales of fresh shrimps and other products from the neighboring coastal fishing villages.

Collection and Preparation of Seafood samples (fresh shrimps *Penaeus notialis*)

Fresh shrimps were randomly purchased from fish sellers at Makoko Better Life market. Purchased samples were immediately put in a sterile screw cap bottles containing enrichment medium (alkaline peptone water) with alkalinity of 8.6 and conveyed to the Microbiology laboratory of the Fish Technology and Product Development Department, Nigerian institute for oceanography and marine research (NIOMR) for further analysis.

Isolation and Identification of isolates

Samples were divided into two sets; one set of the samples was directly cultured onto Thiosulphate Citrate Bile Salt agar (TCBS) and incubated overnight at 37^{o}C. The other set was carried out with a pour plate technique after 18 h enrichment using a 10 fold serial dilution method with TCBS agar. The inoculated plates were incubated overnight at 37^{o}C. Samples were collected in four visits from April 2015 to May 2015 (one month). A total of 90 samples were collected during the period. *V. fluvialis* were identified using conventional microbiological tests which differentiates the various *Vibrio* spp. Gram reaction, oxidase test, motility, sugar fermentation and salt tolerance (Cheesbrough 2000).

Antibiotics susceptibility testing (Kirby- Bauer disk diffusion method)

Cells from each of the pure isolates were harvested from 18 h Tryptone soy broth culture supplemented with 3% NaCl, washed in phosphate buffer (0.05 M, pH 7.0) and resuspended in normal saline with turbidity adjusted to 0.5 McFarland's turbidity level (about 2.0 x108 cfu/mL). These suspensions (0.5 mL) were uniformly spread with a sterile cotton swab on Muller Hinton agar plates supplemented with 3% NaCl and allowed to stand for 5 min. before the antibiotic discs were placed aseptically on the seeded plates (Bauer *et al.,* 1966). Incubation was carried out at 37°C for 24 h. Agar plates inoculated only with bacterial test isolates without the introduction of antibiotic discs served as controls. Zones of inhibition observed around the antibiotic discs were taken with a venire caliper as indications of sensitivity. The 10 antibiotics tested, with their respective concentrations given in parentheses, were: beta-lactams — augmentin (30 μg); fluoroquinolones — ofloxacin (5 μg); ciprofloxacin (5 μg); cephems — ceftazidime (30 μg); amino glycosides — gentamicin(10 μg); nitro furans — nitrofurantoin (300 μig); tetracyclines— tetracycline (25 μg); quinolones – nalidixic acid (30 μg); beta-lactams – amoxicillin (25 μg); folate pathway inhibitors - cotrimoxazole (25 μg). The sensitivity of the isolates and the inhibition zones diameter interpretive standards were assessed in accordance with Clinical and Laboratory Standards Institute (CLSI) document M100 guidelines for Enterobacteriaceae (CLSI, 2010).

Statistical Analyses

Data were analysed using descriptive statistics

Results and Discussion

The frequency and percentage occurrence of *V. fluvialis* in fresh shrimps samples at the Makoko fish market within the four visits from April 2015 to May 2015: are presented in Table 1.

Table 1: Frequency of occurrence of *V. fluvialis* in fresh shrimp samples

No of visits to the Market	Total number of *V. fluvialis* isolates (%)
1	2(12.5%)
2	7(43.75%)
3	3(18.75%)
4	4(25%)
Total	16 (100%)

The susceptibility pattern of *V. fluvialis* against augmentin, ofloxacin, ciprofloxacin, ceftazidime, gentamicin, nitrofurantoin, tetracycline, nalidixic acid, amoxicillin and cotrimoxazole are summarized in Table 2. *V. fluvialis* was more susceptible to ofloxacin, ciprofloxacin, gentamicin, nitrofurantoin, nalidixic acid and cotrimoxazole as compared to augmentin, ceftazidime, tetracycline and amoxicillin.

Table 2: The antibiotic susceptibility pattern of *V. fluvialis* isolated from fresh shrimps brought from Makoko fish market

Total of isolated *V. fluvialis*	AU	OFX	CPX	CEF	GN	NT	TET	NAL	AM	COT
	N (%)									
2	1(50.0)	2 (100)	2(100)	1(50.0)	2(100)	2(100)	1(50.0)	2(100)	1(50.0)	2(100)
7	3(42.9)	7(100)	7(100)	2(28.6)	7(100)	7(100)	4(51.1)	7(100)	3(42.9)	7(100)
3	1(33.3)	3(100)	3(100)	1(33.3)	3(100)	3(100)	2(66.7)	3(100)	1(33.3)	3(100)
4	2(50.0)	4(100)	4(100)	2(50.0)	4(100)	4(100)	1(25.0)	4(100)	2(50.0)	4(100)

*AU: Augmentin (30 µg); OFX: ofloxacin (5 µg); CPX: ciprofloxacin (5 µg); CEF: ceftazidime (30 µg); GN: gentamicin(10 µg); NT: nitrofurantoin (300 µig); TET: tetracycline (25 µg); NAL: nalidixic acid (30 µg); AM: amoxicillin (25 µg); COT: cotrimoxazole (25 µg).
.* N= no of susceptible isolates
*(%) = Percentage of susceptible *V. fluvialis* Isolates

Seafood is known as a vehicle of transmission of food borne bacteria. This study has shown occurrence of *V. fluvialis* in the fresh shrimp samples studied. Similar observations were made by Eyisi et al. (2013), in their studies on distribution of *Vibrio* species in shell fish and water samples collected from Atlantic coastline of south-east Nigeria. Nsofor et al. (2014) also made the same observation in incidence of *Vibrio* species isolated from seafoods sold in Portharcourt. This occurrence may be attributed to the ecology of the study animal (shrimps) and to the high salt tolerance of the organism. It is important to note that isolation of *V. fluvialis* in shrimps might be significantly responsible for gastroenteritis and some severe diarrhea cases among the population of the Makoko community and environs, considering the sources and occurrence in shrimps as observed in this present work. More so, the growing problems with antimicrobial drug resistance are beginning to grind down our antibiotic abilities to fight antibiotic resistance and thus limiting therapeutic options to modern health delivery (Igbinosa, 2010). The epidemiological observation of antimicrobial resistance is crucial for treatment of infections and in preventing the spread of antimicrobial resistant microorganisms. The antimicrobial susceptibility pattern of *V. fluvialis* could be as a result of self-medication. The findings are also in agreement with Sahilah *et al*. (2014) that reported the presence of cefuroxime and ceftazidime-resistant *V. parahaemolyticus* isolates in shellfish samples from Terengganu, Malaysia. This finding was in contrast with Adeleye *et al*. (2008) who had reported a 100% resistance of *Vibrio* species isolated from seafood to nitrofurantoin. This is however expected due to the fact that these drugs are commonly prescribed drugs in human medicine and they are relatively cheap. In addition, the frequency of antibiotic resistance in a population is known to be highly determined by the selective pressure on the commensal microflora due to intake of antibiotics (Harwood *et al*., 2000; Sahoo *et al*., 2010).

To prevent vibriosis, it is clearly necessary to put more emphasis on food hygiene, proper cooking and avoidance of eating seafoods raw should be strongly encouraged. We also need more inspection on the handling and mode of transportation of seafoods in Makoko market.

Patients who present diarrhea symptoms should be referred to the health center for immediate diagnosis and treatment.

Conclusion

In conclusion, *V. fluvialis* was isolated from shrimps sold in Makoko market, the antibiotic susceptibility pattern of the microorganism revealed need of regular surveillance on the use and abuse of antibiotics in the Makoko area.

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Nutritional Evaluation of Fermented *Senna obtusifolia* Seed as a Potential Component of Fish Feed

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Abstract
The nutritional evaluation of fermented senna obtusifolia (linn) seed meal as a potential component of fish feed was investigated. The seeds of Senna obtusifolia were handpicked at Shika Zaria, Kaduna State. Three portions of Senna obtusifolia seeds of 100g each were taken and kept separately prior to treatments. The seeds were soaked in water in a 1:6 (seeds: water) i.e.1kg/6lit ratio for 24hrs, the drained soaked seeds were allowed to ferment naturally. The fermentation periods were 48, 72 and 96 hours. Corresponding to F_{48}, F_{72}, F_{96}, *respectively. The fermented seeds were sundried and grinded into fine powder and the nutrients composition was evaluated. Results revealed that fermentation significantly increased the crude protein contents of Senna obtusifolia seed meal (FSOSM) from 21.12% to 32.11% as the fermentation progressed from 48 to 96hrs. However, the lipid contents was decreased from 7.17% to 4.71% by fermentation. Fermentation also reduced the ash contents but not significantly different (P>0.05) from the raw. Significant reduction (p<0.05) of fibre contents was observed with increase in fermentation time. The moisture content decreased significantly (P<0.05) in the fermented samples. Fermentation for 48, 72 and 96hrs resulted in the decrease of the NFE in this order 51.00, 49.63 and 48.15% respectively, which is significantly different (P<0.05) from the raw sample. Fermentation significantly reduced the ant-nutritional compounds of the seeds. The amino acid (g/100g protein) composition of the raw and fermented Senna obtusifolia shows that Methionine (Met.) had the least value both in the raw and fermented seeds. Though fermentation significantly (p<0.05) improved the amino acid compositions. In conclusion fermented Senna obtusifolia seeds meal contains appreciable quantities of nutrients and amino acids but is limiting in methionine and lysine when compared to the established standard by FAO therefore, its inclusion as supplementary plant protein with other feed ingredients rich in the limiting amino acids to feed fish is recommended.*

Keywords: Fermented Senna obtusifolia seed meal and fish feed

Introduction
Fish feeds accounts for up to 50 to 60% of total expenditure in fish culture business has been reported. The reduction in the cost of fish feeds will enhance the economic status of fish culture business. In recent time, conventional ingredients utilized in fish feeds are costly, which increases the feed cost and in turn increase the cost of fish production. Therefore, the need to utilize less expensive non-conventional feed ingredients to produce fish at low costs is paramount and *Senna obtusifolia* seed meal has great potential in this context. Fermentation has been adjudged a cheap and cost effective food processing method that is affordable by the poor (Omezurike, 2008). Fermentation often results in enhanced nutrition, maintenance of the original raw ingredients and detoxification of anti-nutritional compounds. *Senna obtusifolia* belongs to the *Fabaceae* (Leguminoseae) or bean (pea) family, and sub-family *Ceasalpinoideae.* It is annual weed taxonomically known as *S. obtusifolia*. This is a small fetid herb growing up to an average height from 30 to 90cm (Parsons and Cuthbertson, 1992 and Holm *et al*., 1997). *S. obtusifolia* is extensively used in traditional medicine in tropical and warm sub-tropical countries, the leaves, roots and seeds are used in folk medicine in Asia (Ambasta, 1986). The

proximate composition of the raw seeds show a high dry matter (92.50%), crude protein (29.54%), ether extract (2.31) nitrogen free extract (NFE) (46.77) and crude fibre (10.18%) as reported by (Ingweye *et al*., 2010). It also contains alkaloid, saponin, tannins, oxalate and phytate contents in various concentrations. The hydrogen cyanide concentration is reported to be 6.98mg/100g. The essential amino acids (EAA) of *S. obtusifolia* include phenylalanine, lysine, valine, leucine, isoleucine, threonine, methionine, cystine and tyrosine while the non-essential amino acids are aspartic acid serine, glutamic acid, proline, glycine and alanine. The objective of the study was to determine the nutritional value of fermented *senna obtusifolia* (linn) seed meal as a potential component of fish feeds.

Materials and Methods

Collection and Processing of *Senna obtusifolia* Seeds

The seeds of *Senna obtusifolia* were handpicked at Shika Zaria, Kaduna State. Three portions of *Senna obtusifolia* seeds of 100g each were taken and kept separately prior to treatments. The seeds were soaked in water in a 1:6 (seeds: water) i.e.1kg/6lit ratio for 24hrs, the drained soaked seeds were allowed to ferment naturally (Udensi *et al.,* 2006) without the addition of yeast. The fermentation periods were 48, 72 and 96 hrs. Corresponding to F_{48}, F_{72}, F_{96}, respectively. $F_{48\text{-}96}$ refers to the fermentation periods in hours. The fermented seeds were air dried for two days, then ground into fine powder with hammer mill, packaged and labelled in a polythene bags in preparation for proximate analysis, amino acid profile, mineral elements and determination of anti-nutritive compounds.

Biochemical Analysis of Raw and Processed Seeds

The proximate composition of the raw and fermented seeds, were determined as described by the Association of Analytical Chemistry (A.O.A.C., 2000). The Amino Acid profile in the known sample was determined using the method described by Benitez (1989). All chemical analysis was carried out in triplicate.

Determination of Anti-Nutritional Compounds

The anti-nutritional compounds such as tannins, saponins, hydrogen cyanide, were determined as described by (AOAC, 2000), while Phytate phosphorus and oxalate were determined by the methods of Wheeler and Ferrel (1971) using the procedures of Oke (1969).

Statistical Analysis

All data collected were subjected to one way analysis of variance (ANOVA) using General Linear Model (GLM) procedure of SAS (SAS, 2004). Duncan Multiple Range Test (DMRT) was used to separate means respectively. Values of $P<0.05$ were considered significant.

Results and Discussion

Effects of Fermentation on Nutrient Composition of *Senna obtusifolia*

The proximate compositions of the raw and fermented *Senna obtusifolia* seeds meal (FSOSM) are presented in Table 1.The crude protein content of raw SOSM sample increased from 21.12 ±0.05 g/100g to 32.11±0.06g/100g for FSOSM. The crude protein content for the fermented sample differed significantly ($p<0.05$) than the raw sample. The crude lipid content of the raw *Senna obtusifolia* seed was (5.61%), the crude lipid decreased as fermentation time progressed from 48hrs to 96hrs. The ash content of the raw SOSM (5.42 ±0.38 g/100 g) was slightly higher than that of the fermented (5.40 ±0.21 g/100 g) but insignificantly different ($p>0.05$). The crude fibre content of the fermented sample was lower than the raw sample 8.63±0.35 g/100g and significantly different ($P<0.05$) among treatments and decreased from 5.51 to 5.29%. The moisture content of the fermented sample progressively decreased as fermentation period increased from 48 to 96hrs. The total NFE reduced as fermentation progressed and were significantly different ($p<0.05$).

Table 1: Effects of fermentation time on the nutrients composition of *S. obtusifolia*

Treatment	Crude protein	Lipids	Ash	Moisture	Fibre	NFE
Raw	21.12 ± 0.05^{d}	5.61 ± 0.02^{c}	5.42 ± 0.02^{a}	7.02 ± 0.02^{a}	8.63 ± 0.02^{a}	52.22 ± 0.01^{a}
F 48	25.16 ± 0.06^{c}	7.17 ± 0.02^{a}	5.25 ± 0.02^{b}	5.91 ± 0.02^{b}	5.51 ± 0.02^{b}	51.00 ± 0.01^{b}
F 72	28.74 ± 0.06^{b}	6.15 ± 0.02^{b}	5.40 ± 0.02^{a}	5.05 ± 0.02^{b}	5.03 ± 0.02^{b}	49.63 ± 0.01^{c}
F 96	32.11 ± 0.06^{a}	4.71 ± 0.02^{d}	5.14 ± 0.02^{b}	4.60 ± 0.02^{d}	5.29 ± 0.02^{h}	48.15 ± 0.01^{c}

Means in the same column with different superscripts differed significantly ($p<0.05$) F 48, 72 and 96(fermented seeds at different hours)

Anti-nutritional Compound of Raw and Fermented *Senna obtusifolia* Seed Meal

The anti-nutritional compound of raw and fermented *Senna obtusifolia* seeds meal (FSOSM) samples is presented in Table 2. The phytate concentration in the raw seed was 4.22±0.13g/100g and reduced significantly ($p<0.05$) to 0.28±0.01g/100g for the fermented seed at 96hrs represents 93.4% decrease in the phytate. The tannin in the raw seed was 1.60 ±0.02g/100g which was significantly reduced ($p<0.05$) by 96.3% to 0.06±0.02g/100g in the 96hrs fermented seed. The cyanide concentration reduced from 0.47±0.01g/100g in the raw seed to 0.04±0.01g/100g for the fermented seed at 96hrs representing a reduction of 91.5% reduction. The oxalate 2.44 ±0.020 g/100g in the raw seed meal, was reduced to 0.00±0.003g/100g at 96hrs. Saponin was 2.14±0.08g/100g in the raw reduced significantly ($p<0.05$) to 0.06±0.08g/100g at 96hrs representing a reduction of 97.2% in saponin concentration.

Table 2: Effects of fermentation Periods on the Anti-nutrient of *Senna obtusifolia* seed

Treatments	Phytates	Tannins	Cyanide	Oxalates	Saponins
Raw	4.22 ± 0.13^{a}	1.60 ± 0.02^{a}	0.47 ± 0.01^{a}	2.44 ± 0.01^{a}	2.14 ± 0.08^{a}
F_{48}	0.66 ± 0.01^{b}	0.16 ± 0.02^{b}	0.12 ± 0.01^{b}	0.05 ± 0.01^{b}	0.14 ± 0.08^{c}
F_{72}	0.43 ± 0.01^{c}	0.15 ± 0.02^{b}	0.08 ± 0.01^{c}	0.10 ± 0.01^{c}	0.32 ± 0.08^{b}
F_{96}	0.28 ± 0.01^{d}	0.06 ± 0.02^{c}	0.04 ± 0.01^{d}	0.00 ± 0.01^{d}	0.06 ± 0.08^{d}
% Reduction	93.40	96.30	91.50	100	97.20

Means on the same column with the same superscripts are not significantly different ($p>0.05$) F48, 72 and 96(Fermented seeds at different hours) % Reduction: Percentage reduction in Anti-nutritional compounds

Amino Acid Composition of fermented *Senna obtusifolia* Seed

The amino acid (g/100g protein) composition of the raw and fermented *Senna obtusifolia* is presented in Table.3 Leucine (6.23g/100g protein) had the highest value of essential amino acid while glutamic and aspartic acids (11.92 and 7.82g/100g protein respectively) were the most available non-essential amino acids in the raw seeds. Tryptophan concentration could not be determined because it was hydrolysed by the acid. Methionine (Met.) had the least value both in the raw and fermented seeds. Fermentation significantly ($p<0.05$) improved the amino acids.

Table3: Amino Acid Composition of Fermented *Senna obtusifolia* Seeds

Trt	Ref. value	Raw	F_{48}	F_{72}	F_{96}	SEM
EAA						
Lys	5.80	3.48^{cd}	3.99^{b}	4.08^{b}	4.90^{a}	±0.10
Hist	2.50	2.25^{b}	2.70^{b}	3.47^{a}	3.85^{a}	±0.12
Arg	5.20	5.60^{b}	5.89^{ab}	6.03^{ab}	6.70^{a}	±0.94
Thr	3.40	3.33^{c}	3.86^{ab}	4.10^{ab}	4.35^{a}	±0.08
Val.	5.00	3.88^{abc}	3.96^{ab}	4.05^{ab}	4.11^{a}	±0.04
Met	2.50	0.64^{de}	0.71^{bc}	0.74^{b}	0.86^{a}	±0.02
Iso.	2.80	3.11^{b}	3.05^{c}	3.16^{b}	3.96^{a}	±0.07
Leu	1.10	6.23^{bc}	6.78^{abc}	6.79^{ab}	7.14^{a}	±0.94
Phe.	6.30	3.54^{bc}	3.88^{bc}	4.11^{ab}	4.58^{a}	±0.08
NEAA						
Glu.	14.70	11.97^{ab}	12.02^{ab}	12.11^{ab}	12.26^{a}	±0.10
Ser.	7.00	3.09^{ab}	3.11^{ab}	3.26^{ab}	3.48a	±0.05
Asp	7.70	7.82^{abc}	7.96^{ab}	8.14^{ab}	8.36a	±0.11
Pro.	10.70	2.85^{bcd}	2.98^{abc}	3.16^{ab}	3.33^{a}	±0.06
Gly.	2.20	4.28^{ab}	4.33^{ab}	4.46^{a}	4.88^{a}	±0.11
Ala.	6.10	4.03^{b}	4.11^{b}	4.18^{b}	4.67^{a}	±0.05
Cys	3.00	0.79^{c}	0.86^{c}	0.98^{b}	1.52^{a}	±0.05
Tyr.	1.10	2.86^{b}	3.06^{ab}	3.12^{ab}	3.41^{a}	±0.11

Means on the same row with the same superscript are not significantly different ($p>0.05$)
F 48, 72 and 96: (Fermented seeds at different hours) EAA: Essential Amino Acids NEAA: Non-Essential Amino Acids

Concentration of Amino Acid (g/100gcp) of Raw and Fermented *Senna obtusifolia*

The evaluation of the amino acids based on the classification of the differently fermented *Senna obtusifolia* seed meal is presented in Table 4 revealed that the total amino acid (TAA),Total Essential Amino Acid (TEAA) with histidine and Total Sulpur Amino Acids (TSAA) of the raw seeds were 69.93, 32.24 and 1.42 respectively. Fermentation enhanced the total TAA. Similarly, fermentation progressively enhanced the TEAA and TSAA from 1.57 to 2.38 in F_{48} and F_{96} respectively.

Table 4 Concentration of Amino Acid (g/100gcp) of Raw and Fermented *Senna obtusifolia*

Amino acids	Raw	F_{48}	F_{72}	F_{96}
TAA	69.93	73.03	75.89	83.44
TEAA				
Histidine	32.24	34.60	36.48	40.53
No histidine	29.97	31.92	33.16	36.69
% TEAA				
Histidine	46.10	47.38	48.10	48.57
No histidine	42.86	43.71	43.70	44.00
TNEAA	37.69	38.43	39.41	42.91
%TNEAA	53.90	52.62	52.00	51.43
TSAA(met+cys)	1.42	1.57	1.72	2.38

TAA: Total Amino Acids TEAA:Total Essential Amino Acids TNEAA:Total Non-EssentialAmino Acids TSAA: Total Sulphur Amino Acids F 48, 72 and 96: (Fermented seeds at different hours)

Fermentation of *S. obtusifolia* seeds resulted in increase in crude protein and free amino acids, decrease in crude lipid, crude fiber, and reduced anti-nutritional compounds in comparison to the raw. The increase in nutrient composition of fermented *Senna obtusifolia* seed meal (FSOSM) could be attributed to the biochemical activities of micro-organism that is responsible for the fermentation process and the release of nutrients Yigzaw *et al*. (2004).
The increase in crude protein value through fermentation compare favourably with the values reported for beni seed (Oshodi *et al*., 1999). Increase in protein value with fermentation time has been attributed to net synthesis of protein which results in the production of some amino acids during protein synthesis (Marero *et al*., 1989; Uwagbute *et al*., 2000). The high protein contents could also be attributed to the ability of the micro-organism to secret some extra cellular enzymes which further degraded the pulverised seeds during fermentation (Oseni and

Ekperingin, 2007). The apparent decrease in carbohydrate could be attributed to increased activity of amylolytic enzymes which hydrolyze starch and other complex carbohydrates to simple sugars (Kazanas and Fields, 1981). Similar findings were reported by Achinewhu and Isichei (1990), Nnam (1995) and Onweluzo (2009) on fermented fluted pumpkin seeds, cowpea, millet and pigeon pea respectively. Fermentation reduces the fibre content of the seed probably due to activities of hydrolyzing enzymes such as cellulase, and α-galactosidase produced by the micro-organisms leading to the conversion of insoluble fibre to soluble dietary fibre which are used as a source of energy for cellular activities by micro-organisms (Chandrasekara and Shahidi, 2012). Chitra *et al*. (1996) also reported the reduction in dietary fibre contents of fermented chick pea from 161.1 to 82.4g/kg after fermentation. Similar results were also reported by Oseni *et al*. (2011) when *Jatropha curcas* seeds were fermented. The decrease in lipid content of the fermented seed in this study might be attributed to the increased activities of the lipolytic enzymes during fermentation which hydrolyses lipids into fatty acids and glycerol (Chinma *et al*., 2009). The decrease in ash content of FSOSM could be due to losses of dry matter and volatile materials which normally occur during fermentation. A significant reduction in phytic acid composition in the fermented samples when compared with raw samples might be associated with hydrolysis of phytate via the action of microbial phytase enzymes to lower inositol phosphates (Sandberg, 1991; Hurrell, 2004). Microbial phytases originate either from the micro flora on the surface of cereals and legumes or from a starter culture inoculate (Sandberg, 1991). The lower tannin in the fermented sample could be that tannin-protein, tannic acid-starch and tannin-iron complexes are broken down during fermentation to release free nutrients (Obizoba and Atii 1991). Since tannins are known to reduce the availability of proteins, carbohydrates and minerals through the formation of indigestible complexes (Osagie *et al*., 1996), breakdown of such complexes by fermentation may improve the availability of the nutrients to fish. The lower cyanide level observed could be due to hydrolytic activities of enzymes by the fermenting microorganisms (Montgomery, 1980). Cyanide can also be reduced by boiling and fermentation as a result of alkaline condition of the reaction which breaks down cyanohydrin to hydrogen cyanide which in turn is readily reduced by soaking and fermentation (Liener, 1989). Fermentation caused reduction of 100% oxalate. There is a reduction in the level of saponins in the samples with increasing fermentation time. The amino acid Leucine was the most concentrated essential amino acid while glutamic and aspartic acids were the most concentrated non-essential amino acids in the raw seeds of *Senna obtusifolia*. The values of glutamic and aspartic acids made up to 9.79g/100g protein as the most abundant amino acids in seed sample; similar results have been reported by other workers (Olaofe *et al*., 1994; Oshodi *et al*.,1998; Adeyeye,2004). The limiting amino acids were found to be the sulfur amino acids (methionine + cystine). The lysine and methionine contents of the raw *Senna obtusifolia* seed meal is far lower than protein required for nutrition of finfish (FAO/WHO,1990) hence, this shows that there will be need for supplementation of the meal containing *S. obtusifolia* seed with lysine and methionine. The total sulphur amino acids (TSAA) for the processing method is lower than the 3.2g/100gcp recommended for *Clarias gariepinus* by Fagbenro *et al*. (1998). However, Onimisi, *et al*., (2017) reported substitution of soyabean meal with 25% of Fermented *Senna obtusifolia* seed meal in the diets of *Clarias gariepinus* without any negative effects on the growth and feed utilisation. Nutritive value of a protein depends primarily on its capacity to satisfy the needs for nitrogen and essential amino acids (Oshodi *et al*., 1998). Comparatively, the total values of essential and non-essential amino acid profiles of the fermented sample was slightly higher than in the raw samples. The increased amino acids of fermented *S. obtusifolia* seed meal sample could be attributed to one of the catabolic process which involves the breakdown of proteins into amines and amino acids during fermentation. Trans-amination and deamination reactions might be responsible for the slight changes in the amino acids of the raw and fermented seeds of *Senna obtusifolia* seed meal (Aremu *et al*., 2009).

Conclusion

In conclusion fermented *Senna obtusifolia* seeds meal for 96hrs reduced the anti-nutrient compounds considerably, contains appreciable amounts of nutrients and amino acids but is limiting in methionine and lysine when compared to the established standard by FAO therefore, its inclusion as supplementary plant protein with other feed ingredients rich in the limiting amino acids to feed fish is recommended.

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Reproductive behavior and hatchability of *Tilapia guineensis* stocked in plastic tanks

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Abstract
Reproductive behavior and hatching rate of Tilapia guineensis egg were observed in plastic tanks in the outdoor shrimp hatchery of Nigerian Institute for Oceanography and Marine Research (NIOMR), Lagos, Nigeria. Pair of one male and female broodstock of T. guineensis each was stocked in three plastic tanks measuring 0.9 m X 0.8 m X 0.8 m. The total body weight and length ranged from 50.0-80.4 g and 14.0-16.3 cm respectively. The average body weight and length were 62.5 g and 15.0 cm respectively. Spawning was observed 2-5 days after pairing while the yolk sac absorption occurred within 4-5 days. The paired fish were fed with TOP FEED (4.5mm) at 3% of body weight. The mean number of eggs hatched was 872 eggs per female spawner with average egg diameter of 1.80mm. Hatching of eggs was observed 48-50 hours after fertilization. Egg hatchability ranged from 55.5-95.1% at a mean temperature of 27.4^{o}C. Successful propagation of T. guineensis in plastic tanks and appreciable hatching rates will increase availability of T. guineensis for aquaculture development of the fingerlings in Nigeria.

Keywords: Tilapia guineensis, reproduction, hatchability and plastic tank

Introduction
Tilapia possesses good attributes that make them ideal for aquaculture. They offer the possibility of commercial and cheaply grown protein sources where wild capture fisheries are being depleted (Mandal *et al*., 2009) and Ajiboye, O. O. and Okonji V. A. (2014). The species can be cultured in a wide range of environmental conditions and tolerates stress induced by handling (Tsadik and Bart, 2007, Uka and Sikoki, 2011). *T. guineensis* is euryhailine species found along West Coast of Africa. They are typical substrate spawners, display firm bonding during courtship with prolonged association with the pair establishing and defending a territory. They build spawning nest within the established territory (Legendre and Ecoutin 1989) and (Keremah and Ndah 2013). In recent times, there has been an increase in the culture of tilapia because of increase in demand for fish food, fish meal and other fisheries product. One of the factors responsible for the low level of fish production from brackish water environment is the scarcity of fingerling of brackish water fish species such as *T. guineensis*. As of now, demand for *T. guineensis* fingerings has far outstripped supply in recent times (Horsfall, 2006, Musa *et al*., 2006, Keremah and Ndah, 2013). The availability of fingerlings of *T. guineensis* in the wild is seasonal; hence hatchery propagation of *T. guineensis* will bridge the seasonality of the fingerlings from the wild. This study will produce scientific information on reproductive behavior and hatchabilty of *T. guineensis* in plastic tanks

Materials and Method
Experimental Site
The study was conducted between May and July, 2017 at the Department of Aquaculture, shrimp hatchery complex Nigerian Institute for Oceanography and Marine Research (NIOMR), Lagos, Nigeria.

Collection of Brood fish
Adult *T. guineensis* broodstock of average body length of 15 cm and weight of 62.5 g were obtained from NIOMR Brackish Water Station Buguma, Rivers State. The live fish were packed in

polythene bags, oxygenated and transported in air conditioned vehicle. The fish collected were separated into males and females and acclimatized in two circular tanks of $3m^3$ for a period of 4 weeks. Broodstock were fed with TOP FEED, a commercial extruded floating feed at 3% body weight daily.

Natural Spawning in tanks

Broodstock of *T. guineensis* selected for spawning were separated into males and females. The weight of the broodstock was determined with the aid of Ohaus digital scale, pioneer PA214. They were then stocked at the rate of 1 male: 1 female per plastic tank measuring 0.9 m x 0.8 m x 0.8 m and containing 250L of water. The broodstock were observed in the plastic tank to spawn naturally. They were not fed but water was aerated and changed twice weekly. After spawning the eggs were counted and size was determined by Olympus trinocular microscope equipped with photoscope digital camera DCM35E (350kpixels). The male and female broodstock were removed 3-4 days after the eggs hatched into swim up fry. The fry were siphoned into a bowl and counted. The hatching rate was determined using the equation thus;

$$\text{Percent hatchability (\%)} = \frac{\text{Number of hatched fry}}{\text{Total number of eggs}} \times 100$$

Water Quality Monitoring

Water temperatures, pH, and Ammonia were monitored daily with a mercury-bulb thermometer (0-100^{0}C), pH meter and Lamotte test kit respectively. The fish tank were continuously aerated to ensure enough dissolved oxygen

Results and Discussion

Reproductive Behavior

The female brood stock was observed to spawn 2-5 days after pairing. Prior to spawning, the female brood fish cleaned the corner of the tank where eggs will be dispersed. The females laid their eggs by spreading the eggs at a corner of the tank while the males spread milt on the eggs by swimming over them. The eggs were observed to adhere to the wall of the tanks for 24 – 36 hours before being detached and aggregated by the female to a corner of the tank. The eggs were then moved to other corners of the tank intermittently. Protection, parental care and ventilation of eggs were carried out by both parents. Fertilized eggs were observed to be removed from unfertilized eggs by the male parent with the aid of the mouth. They were deposited at another corner of the tank where the female ventilated the eggs. Hatching of eggs started 48 – 50 hours after fertilization. The fry were protected and ventilated by both parents as they were guarded from one corner of the tank to another. The spawning and hatching rate of *T. guineensis* stocked in plastic tanks is shown in Table 1.The average total body length of the broodstock ranged from 14.0-16.3 cm, while the mean value was 15.0 cm. Average total body weight ranged from 50.0-80.4g, while the mean value was 62.5 g. Spawning took place between 21 and 23 days. Egg diameter ranged from 1.49-1.89 mm, while the mean value was 1.80mm. Average number of egg produced ranged from 964-1211, while mean value was 1090. Average number of hatched eggs ranged from 672-1040, with mean value of 872. Hatching rates ranged from 55.5-95.1%, while the mean value was 74.9%. Values of some water quality parameters monitored during the study are presented in table 2. Temperature ranged from 26.0-29.0^{0}C while pH ranged from 7.50-8.00. Ammonia ranged from 0.05-0.50 mg/L while dissolved oxygen ranged from 4.50-6.50 mg/L.

Table 1: Spawning and hatching rate of *T.guineensis* eggs stocked in Plastic tank

Parameters	Tank 1	Tank 2	Tank 3	Mean Value
Pairing ratio	1:1	1:1	1:1	
Average total body length broodstock (cm)	14	14.7	16.3	15
Average total body weight of broodstock (g)	50	57	80.4	62.5
Spawning time after pairing (days)	2	2	5	3
Spawning frequency (days)	21	23	21	21
Egg Diameter (mm)	1.49	1.62	1.89	1.80
Average number of hatching	904	1040	672	872
Hatchability (%)	94.2	95.1	55.5	74.9
Duration of yolk absorption (days)	5	4	5	4.6

Table 2: Summary means value of water quality parameter recorded during the spawning

Parameter	T1			T2			T3		
	Mean ±SD	Min.	Max.	Mean ±SD	Min.	Max.	Mean ±SD	Min.	Max.
Temperature (ºC)	27.42±0.95	26.00	29.00	27.38±0.96	26.00	29.00	27.41±0.99	26.20	29.00
pH	7.70±0.17	7.50	8.00	7.69±0.15	7.50	8.0	7.64±0.16	7.50	8.00
Ammonia (mg/L)	0.16±0.18	0.05	0.50	0.10±0.06	0.04	0.20	0.07±0.06	0.12	0.30
Dissolved oxygen (mg/L)	5.12±0.47	4.50	6.50	5.31±0.60	4.50	6.50	5.28±0.41	4.50	6.00

Reproductive Behavior

The result in this study on reproductive behavior of *T.guineensis* showed that before spawning took place, female brood fish cleaned the corner of the tank where eggs will be dispersed. The females laid eggs by spreading the eggs at a corner of the tank while the males spread milt on the eggs by swimming over them. This was similar to what was reported from the wild by Campbell, (1987) and Keremah and Ndah, (2013).

Spawned eggs

The females at spawning released 964-1,211 eggs with mean value of 109 0eggs. This agreed with the range of 451-2100 eggs reported by Etim *et al*, 1989, but lower than values of 1035-11170 eggs obtained by Fagade (1978). Bagenal and Braum (1978) reported that number of eggs released during spawning varies widely depending on species, size, age and abundance of food. Average total length and weight of broodstock used in this study ranged from 14.0-16.3 cm and 50.0-80.4 g respectively. These were higher than values of 8.0-9.0 cm and 21-35 g reported by Legendre (1983) and Niyonkuru, (2012) but similar to result obtained by Bome *et al*, (1995).

Eggs and hatchability

The numbers of eggs recorded for each tank were 904, 1094 and 1211 while hatching rates were 94.2, 95.1 and 55.5% for tanks 1, 2 and 3 respectively. This was similar to results obtained by Keremah and Ndah (2013) who reported number of eggs produced as 1269 with hatching rate of 74.9%. The egg diameter ranged from 1.49-1.89 mm with a mean value of 1.80 mm. This was similar to the mean value of 1.48 mm obtained by Keremah and Ndah (2013). Jegede and Fowole (2006) reported that diameter of eggs of *T. zilli* ranged from 1.1-2.0 mm. Yolk absorption was observed for 4-5 days depending on temperature. This agreed with what was reported by Keremah and Ndah (2013).

Water Quality Parameters

This experiment was carried out in fresh water; *T. guineensis* is euryhaline species and can spawn in water environment with salinity ranging from 0 to 17 ppt (Uka and Sikoki, 2011). Water temperature range of 26-29ºC obtained in this study was within the optimal range as reported by Boyd, (1979) and Phippart and Ruwet (1982). pH values were within acceptable range of 7.5 to 8.00. *T. guineensis* can tolerate wide range of pH (5 to 10) but grow and survive best at pH of 6 to 9 (Dannis *et al*, 2009). Ammonia values were within the acceptable range of 0.07±0.06 to 0.16±0.18 mg/L. Dissolved oxygen in this study ranged from 4.5-6.5mg/L which was similar to the value of 4.2-6.2 mg/L reported by Keremah and Ndah, 2013 for *T. guineensis* spawned in glass aquaria.

Conclusion

T. guineensis used for this study exhibited parental care but did not carry out mouth brooding of eggs. The successful propagation *T. guineensis* in plastic tanks under fresh water environment will further enhance Tilapia aquaculture system in Nigeria.

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Capturing, Processing and Utilization of Lantern Fish Species as Replacement for Imported Fishmeal in the Culture of *Clarias Gariepinus* Fingerlings

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Abstract
The capturing, processing and utilization of a deep sea fish species (Lantern fish) was explored. The project was carried out at the Nigeria Institute for Oceanography and Marine Research (N.I.O.M.R) Lagos. The newly acquired research vessel R.V. Bayagbona was used for the survey and capturing of lantern fish along the Nigerian coastal waters. The Simrad EK60 was deployed to determine the depth at which the schools are located. Captured Lantern fishes were sorted into different species onboard the research vessel. A selected species of the lantern fish (Diaphus sp) was further processed into Lantern fishmeal. Absolute replacement of imported fishmeal with Lantern fishmeal in the diet of Clarias gariepinus fingerlings was carried out. Data were generated for total weight gain (TWG), specific growth rate (SGR) and feed conversion ratio (FCR), Results obtained was not significantly different (P > 0.05) in feed conversion ratio (FCR) between fishes fed Lantern fishmeal based diet and fishes fed imported fish feed. Feed conversion ratio (FCR) was best in fishes fed Lantern fishmeal based diet. However, no significant difference (P > 0.05) was observed in their growth performance. It can be concluded that, harnessing the potentials of Lantern fish vis-à-vis Lantern fishmeal in the diet of Clarias gariepinus fingerlings has proven to be a good substitute to the imported fishmeal.
Keywords: Lantern fish, R.V. Bayagbona, Fishmeal and Aquaculture

Introduction
Fishmeal is the main and preferred source of protein used in agricultural feed industry because of the excellent nutritional composition. However, the rising demand and limited supply makes fishmeal an expensive protein source (FAO, 2006). The cost of imported fishmeal in 2004 ranged from US$870 – 1, 350 per tonne, while the cost of locally produced fishmeal was US$1 500 per tonne (Ayinla 2007). The inconsistent supply, the growing demand and price among other problems are limiting the use of fishmeal and putting a great pressure on the feed resource industry. In 2000, an estimated 65, 253 tonnes of fishmeal was available in Nigeria, of which 13.4 percent was locally produced and the rest imported, mainly from Norway and Denmark (Fagbenro and Adebayo, 2005). The escalating price of fishmeal, coupled with its scarcity, has stimulated research into ways of replacing imported fishmeal with other high protein natural alternatives. Nigeria's small-scale fishmeal industry could possibly be expanded by developing a fishery for the unexploited lantern fish resources in our national waters (Ayinla, 2007).
Since nutrition represents over 70% of total variable cost of culture inputs, the major challenge facing the aquaculture industry is the production of cost effective diets for farmed fishes, using inexpensive, locally available ingredients. This simply means that searching for unconventional, cheap feed inputs as an alternative to imported fishmeal is a must. Alternative protein sources such as soybean meal (Richardson *et al.*, 1985; Gatlin and Philips, 1989), yeast (Mahnken *et al.,* 1980; Tacon and Jackson, 1985; (Tacon, 1994) have been tested using different models. Lantern fish (a deep sea fish) is abundant in Nigeria's coastal waters and are yet to be exploited. Thus, the aim of this study therefore is to harness the advantage of prolificacy of lantern fish species which

are un-taped in our coastal water bodies to produce local fishmeal and reduce the importation of fishmeal. Fish feed will be cheaper, employment generated, more fish produced, farmers income increased and aquaculture production to National GDP will greatly be increased.

Methodology

Sample collection

Field sampling for Lantern fish was done with a pre-planned and agreed sampling area starting from the west-coast along the international water boundary with Benin Republic and the eastern boundary of Ogun State with Ondo State (Figure 1). Acoustic surveys to estimate stock biomass and trial fishing using pelagic trawls were also carried out.

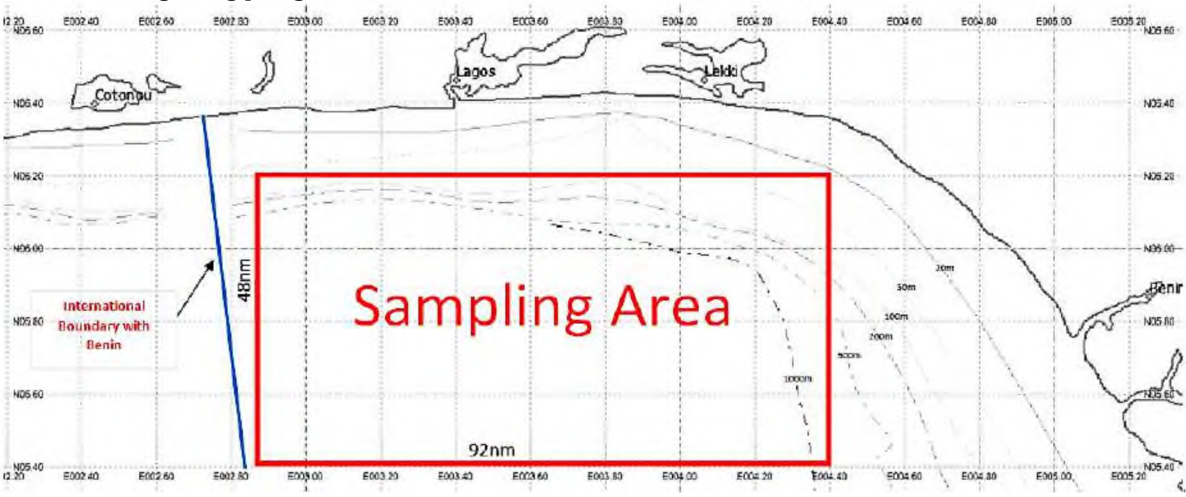

Figure 1: The sapling area for offshore Lagos and Ogun States

Table 1: Coordinates of the extremes of the sampling area

Points	Latitude	Longitude
A	6° 12' 000	2° 54' 000
B	6° 12' 000	4° 24' 000
C	5° 24' 000	4° 24' 000
D	5° 24' 000	2° 54' 000

The fish sonar and the sensor monitoring screens at the bridge were used to scan and monitor the water for school of fish before the trawl net was deployed (Fig. 2). The Simrad EK60 in the Instrumentation Room was also used to determine the depth at which the schools at located. Although the interpretation of the displayed echograms observed were not clearly understood, we still used it to search for schools of fishes based on our levels of interpretation. The sensors monitor gives the readings on the opening, height, amount of catch in the trawl net while the Simrad gives both the water depth and the depth of the schools of fish.

Deployment and Retrieval of the Trawl Net

After a school of fish had been spotted on the echogram, the trawl net would be deployed before we approach the school of fish (Fig. 2). Trawling operation is dependent on the depth at which the school was spotted and the direction of movement. Trawl duration lasted between one to two hours and the trawl speed between 2 to 4 knots.

Fig. 2: Deployment and retrieval of trawl net during the day (A) and night (B)

Trawls catch assessment and sorting

After a successful haul on deck, the sub-samples were taken to the fish processing unit for sorting, identification with each species counted and weighed (Fig. 3). Length frequencies of each species were measured and recorded. The measured samples were bagged for further laboratory analysis.

Fig. 3: Fish on deck (A), hauling into basket (B), sorting (C) and individual species sorted (D)

Processing of lantern fish into fishmeal

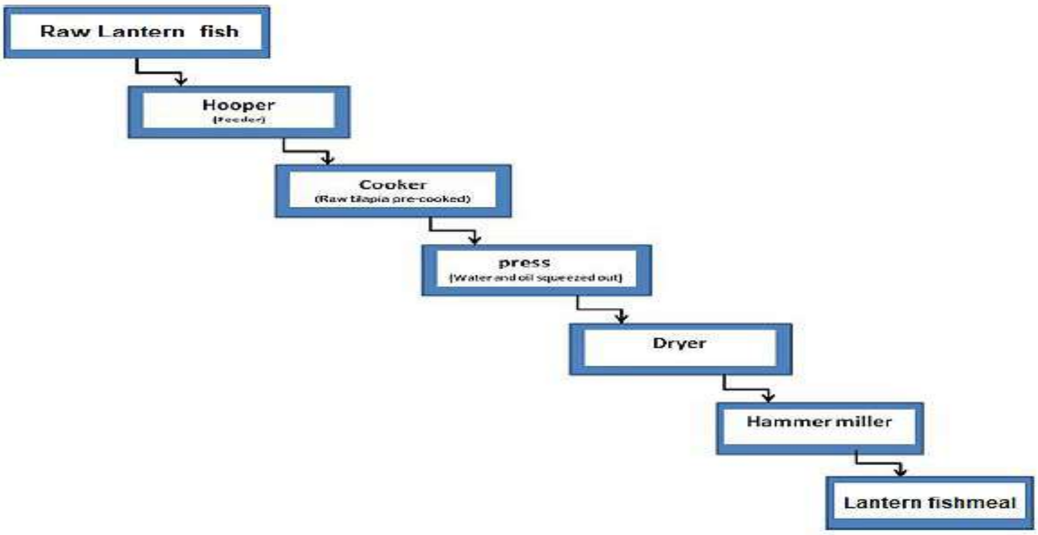

Fig 4: Flow Chart Describing NIOMR Fishmeal Processing Plant for Lantern fishmeal production

Fig. 5: Compact Fishmeal Processing Plant (Denmark, type FR100)

Processing of Lantern fish into Lantern fishmeal using a compact fishmeal processing machine (Denmark, type FR 100)

Fishes were processed into Lantern fishmeal using a compact fishmeal processing plant (Denmark, type FR100) (Fig. 5). **P**rocessing method involved feeding fresh Lantern fish into a cooker through the hopper situated above the plant. The cooker consists essentially of a long steam jacketed cylinder through which the fish is moved by a screw conveyor with a steam injector connected above it. The raw fishes are pre-cooked at a holding temperature of about 70 - 80^{o}C for about 5 - 15 minutes. The coagulated mass then enters a press situated at the middle of the component. In this component**,** the fish is conveyed through a perforated cylindrical tube whilst being subjected to increasing temperature. Water and oil are squeezed out through the perforations leaving a pressed solid cake which then enters a drum-like drier situated at the base of the machine. The product; a mixture of dried coarse Lantern fish flesh, scales and bones are then milled to produce a finely milled Lantern fishmeal powder (Fig. 4).

Proximate Analysis of Feed ingredients

Analyses of crude protein, crude fibre, ether extracts, ash and moisture contents was carried out in triplicates, generally following AOAC (1995) procedures. Dry matter (DM) was determined by drying 5 g of sample to constant weight in an oven at 103°C. Ash content was also determined by ashing the 5 g at 550°C in a muffle furnace for 4 ½ hours. Crude protein (CP) was quantified by the standard micro-Kjeldahl method, using a sample size of 0.4 g.

Determination of growth Indices

The Final weight, Total weight gain, Specific Growth Rate (SGR) and Feed Conversion Ratio (FCR), were calculated.

Statistical Analysis

All data resulting from the experiment were analyzed by one way analysis of variance (ANOVA) using the SPSS (statistical Package Computer, Software 2004 version Chicago Illinoise, USA). Duncan's multiple range test for least significant difference were used to compare differences among individual means. Differences were regarded as significant at $P < 0.05$ (Zar, 1999).

Results and Discussion

Chemical Composition

Dried Lantern fishmeal was analyzed for its chemical composition Fig 3. Results show that, crude protein, Lipid and Ash content were 62.4%, 6.32% and 6.5% respectively.

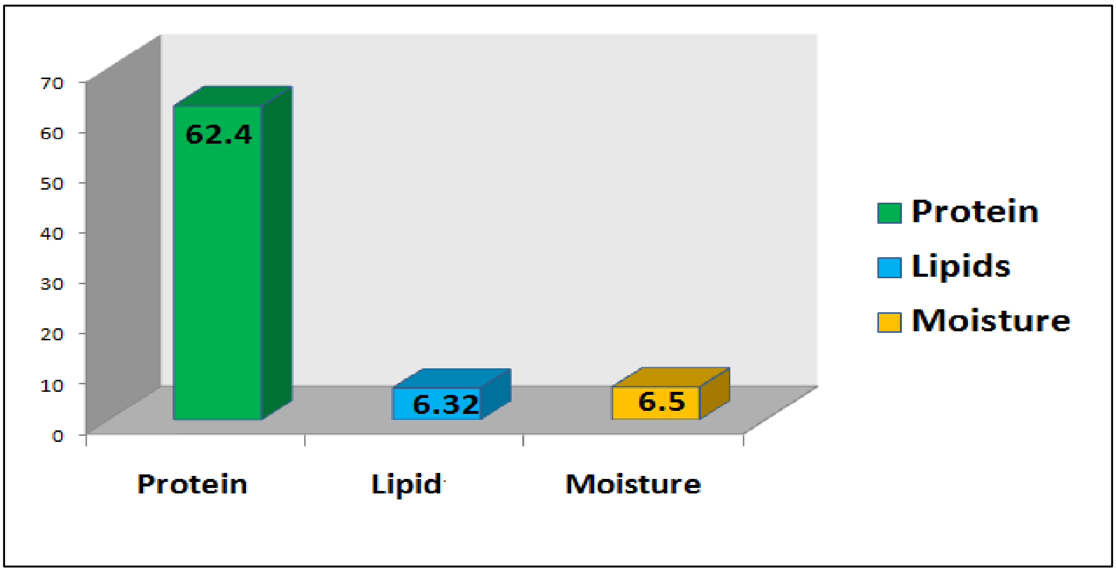

Fig 6: Chemical composition of Dried Lantern fish

Growth Performance of *C. gariepinus* Fed Plant protein based feed (A), Imported feed (B) and Lantern based feed (C)

The mean cumulative weight gain of the experimental fish (*Clarias gariepinus*) fed Plant protein based feed, Imported feed and Lantern based feed for 8 weeks revealed that. The initial weight of the fish at the point of commencement of feeding trial was 20.05g, 20.09g and 20.10g for treatment A, B and C respectively while the final weight gain was 807.0g, 1,162.5g and 1,178g for treatment A, B and C respectively. The group of fishes fed Lantern fishmeal based (C) had the highest weight gain (1,178g). While the groups of fishes fed plant protein based diet recorded the least weight gain (807.0g). The groups of fishes fed Lantern fishmeal based had the lowest FCR (2.16) while the highest FCR (3.89) was recorded for the fishes fed with plant protein based diet. However, SGR was the same for all treatments (Table 2, Fig 6 and Fig 7).

Table 2: Feed Utilization of _C. gariepinus_ Fed Plant protein based feed, Imported feed and Lantern based feed

Parameters	Plant protein based	Imported feed	Lantern based
Culture Period (weeks)	8	8	8
Initial Weight of Fish/ tank (g)	20.05	20.09	20.10
No Stocked	22.00	22.00	22.00
Final weight of Fish/ tank (g)	807.00	1,162.50	1,178.00
Weight Gain of Fish/ tank (g)	786.95	1,142.41	1,157.90
SGR	0.03	0.03	0.03
FCR	3.89	2.20	2.16

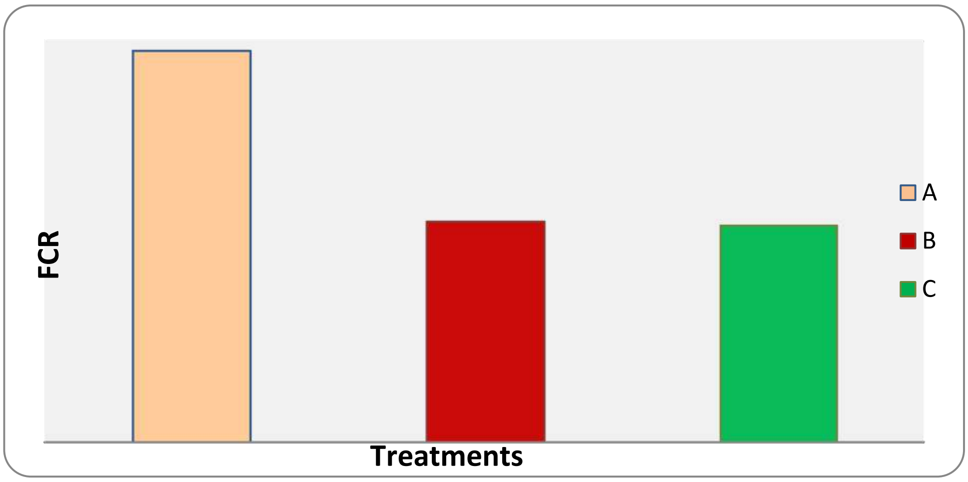

Fig 7: Feed Conversion Ratio (FCR)
Key: (A= Plant based feed, B= Imported feed, C= Lantern based feed)

Lantern fish represents a virgin resource in the Nigerian territorial waters. Because of its potential importance for fishmeal production there has been great interest by the Nigerian Institute for oceanography and marine research (NIOMR) during the last decade to start commercial exploitation of this untapped natural resource. The present study entails the feeding trial of _C. gariepinus_ fed Lantern fishmeal based diet. The nutritional quality of treatment containing Lantern fishmeal based diet as compared by Duncan's multiple range tests for least significant difference was adequate. Although final body weight and growth rate were higher in fish fed diet containing Lantern fishmeal based diet, no deleterious depression in growth was observed in fishes fed imported feed. Secondly, one of the most common difficulties observed when alternative sources of feedstuffs are used in fish diets is acceptance and palatability of the feeds by the fish (Domingues _et al._, 2003, Rodriguez _et al._, 1996 and Adewolu, 2008). Lantern fishmeal based diet treatment was accepted by _C. gariepinus_ fingerlings, indicating that absolute replacement of fish diet containing imported fishmeal with Lantern fishmeal did not affect palatability and acceptance of the diets. This might be due to the processing technique employed in this study owing to the adjusted minimal processing temperature of Lantern fish into fishmeal and of cause, the preference of fish eating fish. Feed conversion ratio (FCR) is an important economy indicator in fish production. FCR is a marker of how efficiently an animal utilizes feed, therefore minimizing feed wastage. Low FCR is usually desired in feed production. In general, the FCR observed in this study revealed that feed utilization were best in fishes fed with Lantern fishmeal based diet. The FCR of fishes fed with imported feed were also adequate.

This value supports the results by other researchers that evaluated alternative dietary protein sources to fish meal. Muzinic _et al._, (2006) reported FCR range of 1.70-1.78 when turkey meal was used at various replacement levels in diets for Sunshine bass which agrees with the results obtained in this study for _C. gariepinus_ fingerlings fed Lantern fishmeal based diet. Rawles _et al._, (2006) also reported an FCR range of 1.58-1.72 when poultry blood meal was used to replace fishmeal in diet for hybrid striped bass which is similar to the findings of this study. The carcass composition of *C. gariepinus* fishes fed diets containing Lantern fishmeal based diet and imported feed at the end of experimental period did not also differ significantly ($p > 0.05$). This might be due to the near constant protein content of the experimental diets. In conclusion, it is well known that marine resources offer a vast range of opportunity to solving the problems of fishmeal and fish oil in Nigeria. The responsible use of this deep sea fish species; Lantern fish, principally by the animal feeds industry is therefore important.

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Occupational Competencies Needed by Retirees in Fish Production for Sustainable Livelihood in Rivers State

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Abstract
This study was designed to identify occupational competencies needed by retirees in fisheries production for sustainable livelihood in Rivers State. Three research questions guided the study. The sample for the study was two hundred and fifty four (254). A 74-skill item questionnaire was developed from literature reviewed. Pilot study was carried out in order to determine reliability of the research instrument through Cronbach's Alpha which measured the internal consistency. The pilot study was conducted with selected thirty (30) Extension Agents and Ten (10) Registered retired fish framers using the split half method which yielded a co-efficient of 0.81 and 0.78 respectively. Two hundred and fifty four (254) copies of the questionnaire were administered on the respondents through the help of three (3) research assistants. All the copies of the questionnaire were retrieved and analyzed using weighted mean and Improvement Need Index (INI) for the research questions. It was found out that retired fish farmers needed occupational competencies in pond construction and stocking of the pond for sustainable livelihood in Rivers State. It was recommended that the findings of this study be utilized to develop occupational competencies programmes for retaining retiree fish producers for greater efficiency.
Keywords: Occupation, Competency, Retiree, Sustainable and Livelihood

Introduction
According to FAO (1988), aquaculture is the farming of aquatic organisms, including fish, mollusks, crustaceans and aquatic plants in an open water body or in an enclosure. Aquaculture, like any other aspect of agriculture, is now a lucrative business venture for sustainable livelihood. Owing to the drive agriculture is having on the Gross Domestic Product(GDP) in Nigeria occasioned by government support to the sector, every retiree would want to practice one form of agriculture or the other to sustain livelihood. In Rivers State, with the natural disposition, retirees often opt for fish farming even though they may not have gotten the required experience. They may only realize after retirement that they did not really had pre-retirement plan for sustainable livelihood. In the observation of Amusa and Dumbiri (2010), most retirees lack basic occupational competencies for self-re-engagement after service. As a result, they associate fear with livelihood challenges on retirement. Jerry (2009) clarified that the fear of life on retirement is due to lack of productive competencies. In Rivers State, it is often observed that most to-be-retirees are frequently depressed by the uncertainty of how to continue to make sustainable livelihood on retirement. Majority of them, therefore, end up in highly strenuous and flexible business with high level of risks of failure which in most cases lead to hypertension and in extreme cases death of the individual. Owing to improper retirement plans and the bureaucratic bottlenecks associated with retirement packages provided by the government, retirees in Nigeria face hardships such as financial insufficiency, poor feeding, and inability to pay life sustaining bills. Others include dysfunctional family matters as well as psychological or behaviour disorders like depression, hypertension, identity crisis, alcoholism, loneliness, fast ageing and ill health occasioned at times by loss of good accommodation among others (Inaja, 2007). Ayodeji and Theresa (2013) also observed that many retirees in the Nigerian society and the problems they are facing draw the attention of all and sundry. These problems seem to range

from sudden loss of life, loss of the usual monthly salary, anxiety about a residential home, lack of occupation, dwindling status, decreased strength and deteriorated health condition, physical disabilities and aging. However, Harris and Cole (1980) noted that retirement may be an advantage between one career and another; it may represent the opportunity to start one's real life work or to draw two pay checks. Meanwhile, Rivers State FADAMA 111 (2010) reported that most women in agriculture and retirees have indicated interest in fish production occupation because fish thrives well in the state while its supply to the market is lower than the demand by consumers and marketers who export it outside the state. In this study, retirees in fish production solve problems and obtain information, skills and technologies to improve their livelihood and well-being. It was in the expectation of the researcher that the retirees be trained to establish and manage fish production business for sustainable livelihood, but no such record exists. Recent observation shows poor production and low income by the fish farmers due to lack of knowledge of new techniques in the methods of fish production and marketing, as such sustainable livelihood is difficult. To avert this situation therefore, retirees fish farmers needs occupational competence. But the question is what are the occupational competence needs of retirees in fish production? It is against this backdrop, that the study seeks to identify occupational competencies needed by retirees in fish production for sustainable livelihood in Rivers State.

Methodology

This study was carried out using the survey research method. The population of the study consisted of all Extension Agents and registered retiree fish farmers in Rivers State. A sample size of fifty-four (54) Extension Agents and two hundred registered retirees fish producers in the State were randomly selected from the twenty three Local Government Areas . The research instrument used for data collection was a structured questionnaire. Copies of the instrument were administered by the researcher, along with the three research assistants. This was to allow for easy administration of the questionnaire to the Extension Agents and retirees fish producers in Rivers State. The research questions were answered using weighted mean and Improvement Need Index (INI).

Occupational competencies of the retirees fish producers were determined as follows:

a. The weighted mean ($\bar{X}n$) of the competency importance rating was determined for each item.
b. The weighted mean ($\bar{X}p$) of performance rating was determined for each item.
c. The performance (PG) was determined by finding the difference between the values of $\bar{X}n$ and $\bar{X}p$. That is, $PG = \bar{X}n - \bar{X}p$

A negative PG means that occupational competency is needed because the level at which the retiree fish producer could perform that item is greater than the mean importance rating. A zero PG implies that improvement is not needed because the level at which the retiree fish producer could perform the item is equal to the mean importance rating it is needed. Whereas, a positive PG means that occupational competency is needed because the level at which the retiree fish producer could perform the item is lower than the mean importance rating (Olaitan et al. 2000). The occupational competency needs of the retiree fish producers were therefore prioritized according to the gap between improvement rating and level of possession. The higher the value, the higher the need for occupational competency.

Results and Discussion

The analysis were based on the data gathered from the 254 respondents. The data collected are presented as analyzed in the tables below:

Table 1: Performance gap analysis of the mean ratings of the responses of retiree fish producers and Extension Agents in Pond Construction in Rivers State

S/N	Items	$\overline{Xn}$	$\overline{Xp}$	PG	Remark
1.	Clear pond site for construction	3.33	3.68	–0.35	NNED
2.	Excavation of the soil	3.23	3.78	–0.55	NNED
3.	Prepare bottom soil with river sand	4.08	2.45	1.63	OCN
4.	Fence pond site	3.38	3.45	0.43	OCN
5.	Treat fish pond with antibiotics	4.05	3.74	0.31	OCN
6.	Lime the pond with calcium materials when needed	4.36	3.71	0.65	OCN
7.	Combine appropriate mixture of cow and poultry dung to make planktons bloom in the pond	4.25	2.10	2.15	OCN
8.	Use suitable plants to provide shade for the pond	3.65	3.34	0.20	OCN
9.	Fertilize pond with organic and inorganic manure	4.98	3.30	1.68	OCN
10.	Fill the pond with water	3.70	3.65	0.05	OCN

Results in Table 1 reveals that the performance gap value of eight (8) out of ten (10) items ranged from 0.05 to 2.15 and were positive. This shows that retiree fish producers need occupational competency in the 8 items on construction of ponds skill in fish production and marketing enterprise.

Two of the ten skill items had a performance gap –0.35 to 0.55 which indicate that the retiree fish producers do not need occupational competency on those items. On the average, the retiree fish producers need occupational competencies.

Table 2: Performance gap analysis of the mean ratings of retiree fish producers and Extension Agents for producing fish for sustainable livelihood

S/N	Items	$\overline{Xn}$	$\overline{Xp}$	PG	Remark
1.	Stock pond with the right fish	3.98	2.64	1.34	OCN
2.	Stocking at optimum density	3.45	3.18	0.27	OCN
3.	Remove rough vegetation such as bushes	2.85	4.24	–1.39	NNED
4.	Check the water level regularly to avoid water running through the outlet	2.70	3.69	–0.99	NNED
5.	Attend to any repairs to the outlet and inlet after proper checking on them	3.61	2.78	0.83	OCN
6.	Fill cracks, replace worn bricks or concrete	3.72	2.38	1.34	OCN
7.	Regularly drain and change water	2.52	3.96	–1.44	NNED
8.	Maintain good water quality	3.17	2.44	0.74	OCN
9.	Test cropping	3.39	2.58	0.84	OCN
10.	Keeping farm records	3.84	2.73	1.11	OCN

Table 2 reveals that the performance gap values of seven (7) skill items range from 0.27 to 1.34 and were positive. This shows that the retiree fish producers need occupational competency in the seven skill items. Three (3) out of the ten (10) skill items had a performance gap value ranging from –0.99 to –1.44 which indicate that the retiree fish producers need occupational competency in the stocking of fish. Analysis of data indicated that retiree fish producers need occupational competency in pond construction and stocking. These findings are in conformity with those of Amusa and Dumbiri (2010) who reported that most retirees lack basic occupational competencies for self-re-engagement after service. They further recommended that to-be-retiree farmers need to be properly trained to become successful farmers after retirement. Abu (2008), in a study on "improvement Needs of to-be-Retiree Farmers in Soil Conservation in Kogi State, Nigeria," also reported that they require improvement in competencies to manage their farms.

Conclusion

From all indications, retiree fish producers in Rivers State lack occupational competencies for sustainable fish production for livelihood food security. It is therefore recommended that retirees be properly trained by relevant organizations on aquaculture in all ramifications before embarking on the venture to avoid losing their investment.

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Occurrence of Public Health Important Bacteria among Freshly Caught Fin Fish and Shell Fish from Nigerian Coastal Waters

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Abstract

The presence of total coliform, fecal coliform, Vibrio, Salmonella and Shigella species in the muscles two common finfish Shyraena piscatorum (Baracuda) and Chrysichthys nigrodigitatus (Silver cat fish) and shell fishes Penaeus notialis (pink shrimp) and Callinectes sp. freshly caught from coastal waters in Lagos and Ondo state was assessed in April and July 2018. After culture on appropriate growth media using the traditional spread plate method, a total viable count range of 4.0 $x10^2$ to 5.0 $x10^3cfug^{-1}$ (total coliform); 4.0 $x10^2$ to 1.2 $x10^4cfug^{-1}$ (fecal coliform); 4.30 $x10^2$ to 1.44 $x10^4cfug^{-1}$ (Vibrio species.), 9.0 $x10^2$ to 3.1 $x10^3cfug^{-1}$ (Salmonella Shighella species) was observed in both the fin fish and shell fish. Although the bacterial abundance varied among the different types of seafood. There was also a significant variation in the occurrence of the organisms during the two sampling period. This study indicates possible fecal contamination of our coastal waters and poor sanitary/handling practices of the fisher folks. There is a public health threat of outbreak of foodborne infections due to consumption of these contaminated seafood especially when not properly cooked.

Introduction

Fish and other seafood has always been part of human diet, however the consumption of seafood has recently increased due to the awareness of the high nutritional value especially its low cholesterol, fat content and good quality of animal protein (Quintoil 2007, Iwamoto *et al*., 2010; Sudha *et al*., 2012; Costa 2013). Seafood are carriers of a variety of microorganisms such as bacteria, fungi, viruses and parasitic pathogens. Among these microbes are human pathogens capable of causing from mild gastroenteritis to life-threatening diseases, including *Escherichia coli, Salmonella sp., Shigella sp., Staphylococcus sp., Clostridium botulinum, Vibrio, Pseudomonas, Erysipelothrix, Leptospira, Pasteurella, Mycobacterium* and *Aeromonas*. Indeed, a significant percentage of foodborne diseases worldwide has been associated with seafood. They acquire these organisms through feacal pollution of the aquatic environment and poor handling after capture (Abeyta 1983, Iwamoto *et al*., 2010; Ariyawansa *et al*., 2016; Nrior *et al*., 2017; Sudha *et al*., 2012). Nigerian coastal waters like other coastal waters around the world is endowed with rich fishery resources, this serves as prominent source of food and income for both the people living in the coastal areas and the entire country at large. The coastal waters are also prone to contamination through domestic and industrial sewage, the main source of pathogenic microbes being domestic and hospital wastes (Thayumanavan *et al*., 2003 and Quintoil 2007**)**. As a potential source of foodborne diseases, there is need for continuous monitoring of the bacteriological status of seafood in order to establish the safety of the consumers. This study therefore is an attempt to determine the bacteriological status of our fishery resource. This will ensure effective and sustainable management system and enlighten the issues of public health and consumer safety.

Materials and methods

Collection of Fish samples

Samples of two different popular species of fresh fin fish *Shyraena piscatorum* (Baracuda) and *Chrysichthys nigrodigitatus* (Silver cat fish) and shell fishes *Penaeus notialis* (shrimp) and *Callinectes sp*. (crab) were bought from the landing sites at Makoko Lagos state and Igbokoda, Ondo state in April and July 2018. The samples were placed in clean polythene bags and preserved in ice chest and transported to the laboratory where analysis commenced within 24 hours. At the laboratory of Department of Biological Oceanography, Nigerian Institute for Oceanography and Marine Research, Lagos, the representatives of the skin of fin fish and shell of the shell fish were aseptically removed and muscles and internal tissue respectively macerated using sterile pestle and mortar.

Bacteriological Analysis

A total of ten grams (10g) of the macerated fish samples were added to ninety milliliters (90ml) of sterile peptone water, this was subsequently serially diluted and aliquots (0.1ml) of appropriate dilutions inoculated into specific agar plates for isolation and enumeration of the different groups of bacteria using spread plate method. The total coliforms and fecal coliforms were cultured on MENDO and MFC agar (Biomark Inc.) respectively. However, *Vibrio* species and *Salmonella/ Shigella* species were isolated on Thiosulphate - Citrate – Bile - Sucrose (TCBS) agar and Salmonella Shigella agar (Oxoid) respectively. Incubation of fecal coliforms was carried out at 44^{o}C while the others were at 37^{o}C for 18 to 24 hours after which the viable discrete colonies were counted.

Statistical Analysis

The analysis of variance (ANOVA) were determined using Prism version 5.03 computer software program (GraphPad Software, San Diego, CA. USA). Tests were carried out at 5% significance level.

Results and Discussion

Total viable count of bacteria in the two fresh fin fishes (*S. piscatorum* and *C. nigrodigitatus*)

During the first sampling in April, an average of 4.55 x 10^3 cfug^{-1} of total coliform, 3.15 x 10^3 cfug^{-1} of Feacal coliform; 1.44 x 10^4 cfug^{-1} *Vibrio* sp. and 9.0 x 10^2 cfug^{-1} of Salmonella Shigella sp. was observed in *S. piscatorum* (Figure 1). A lower bacteria count (2.95 x 10^3;4.0 x 10^2 and 8.50 x 10^3 cfug^{-1}) was however noted for all bacterial groups with exception of the *Salmonella Shigella* sp., which had a higher number of 1.15 x 10^3 cfug^{-1} at the second sampling in July for *S. piscatorum.* Two-way analysis of variance showed a significant difference ($p<0.0001$) in the population of the different bacteria groups, also there was a significant variation ($p<0.0001$) in the number of bacteria encountered in the two different sampling period. Similarly, *C. nigrodigitatus* had higher number of total coliform (4.45 x 10^3 cfug^{-1}), feacal coliform (7.30 x 10^3 cfug^{-1}) and Salmonella Shigella sp. (2.10 x 10^3 cfug^{-1}) in April sampling but more of the *Vibrio* sp. was observed in July (8.70 x 10^3 cfug^{-1}) compared to the initial value 6.05 x 10^3 cfug^{-1}. Nevertheless, a significant difference was noted among the bacterial group and sampling time with p-values of 0.0007 and 0.0099 respectively.

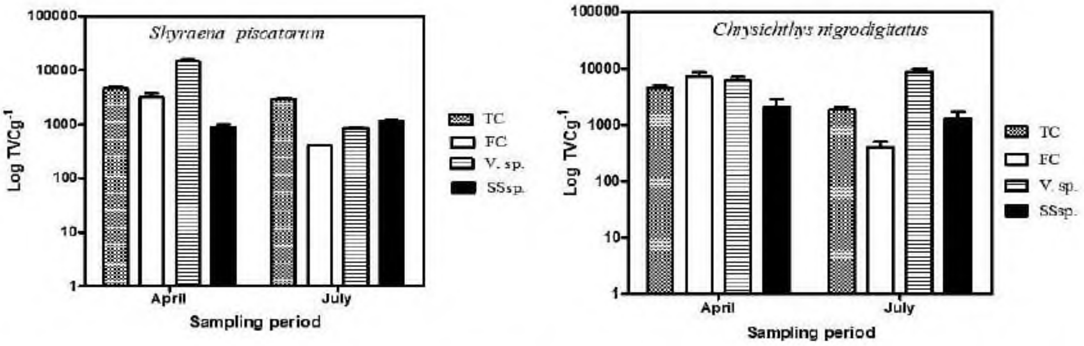

Figure 1 Total viable count of different bacterial groups total coliform (TC), Feacal coliforms (FC), *Vibrio* sp. (V.sp) and *Salmonella Shigella* sp.(SS sp.) on the two fin fish (*Shyraena piscatorum* and *Chrysichthys nigrodigitatus)*

Total viable count of bacteria in the two fresh shell fishes (*P. notialis* and *Callinectes sp.)*

As depicted in figure 2, in the first sampling period, the bacterial count noted for *P. notialis* was total coliform 5.0 x 10^3 $cfug^{-1}$; feacal coliform 1.20 x 10^4 $cfug^{-1}$; *Vibrio* sp. 9.50 x 10^2 $cfug^{-1}$ and *Salmonella Shigella* sp. 1.15 x 10^3 $cfug^{-1}$. However, the counts observed at the second sampling period for the respective bacterial groups was 2.5 x 10^3; 1.10 x 10^3; 1.28 x 10^4 and 9.50 x 10^3 $cfug^{-1}$. The bacteria viable count differed significantly among the different groups (p= 0.0006) and during the sampling periods (p=0.0115). On the other hand, *Callinectes sp.* had 2.05 x 10^3 $cfug^{-1}$ (TC); 2.40 x 10^3 $cfug^{-1}$ (FC); 3.2 x 10^3 $cfug^{-1}$ (*V. sp.)* and 1.25 x 10^3 $cfug^{-1}$ (*SS sp*.) during the April sampling. Meanwhile, at the second sampling, the population of total coliform, feacal coliform and *Vibrio* sp. reduced to 4.0 x 10^2, 1.95 x 10^3 and 4.30 x 10^2 $cfug^{-1}$ respectively but more (3.05 x 10^3 $cfug^{-1}$) of *Salmonella Shigella* sp. was noted. Interestingly, the variation in the bacteria population among the different group (p=0.34) and sampling time (p=0.08) was not significantly different for *Callinectes sp.*

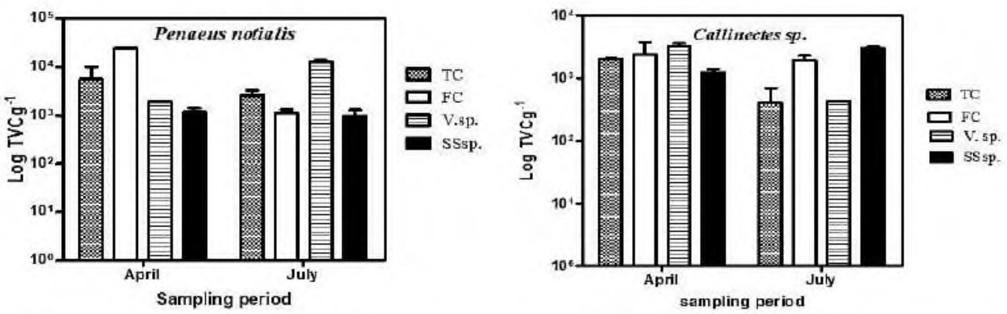

Figure 2 Total viable count of different bacterial groups total coliform (TC), Feacal coliforms (FC), *Vibrio* sp. (V.sp) and *Salmonella Shigella* sp.(SS sp.) on the two shell fishes *Penaeus notialis* and *Callinectes sp.*

The muscles of both the fin fish and shell fish in this study was contaminated with the different groups of bacteria including coliforms, fecal coliforms, *Vibrio* species and *Salmonella Shigella* species. This is contrary to the generally accepted fact that the muscles of freshly caught seafood are free from microorganisms. It has however been noted that the presence of microbes in freshly caught fish could be due to environmental contamination and poor handling by fisher folks (Iwamoto *et al*., 2010; Ariyawansa *et al*., 2016, Nrior *et al*., 2017). The coliform bacteria particularly *Escherichia coli* is a normal flora of human and other warm-blooded animals. It is usually abundant in their feces therefore; its presence in food or water commonly indicates direct or indirect fecal contamination. It is not surprising that these organisms were present in the fish from because earlier studies have reported the abundance of these organisms in Nigeria coastal waters (Ajayi and Akonai, 2005; Agwu and Oluwagunke, 2014). According to Mahalakshmi *et al* (2011), the introduction of microbial pathogens, including the ocean indigenous *Vibrios* and the allochthonous bacteria *E. coli, Salmonella* sp. and *Shigella* sp. is one of the major implications of the discharge of sewage and industrial effluents in the aquatic ecosystem. These pathogens affect the sustainability of living resources and public health. The difference in the abundance of the microorganisms during the sampling period could be attributed to the changes in the environmental factors during sampling. Environmental parameters such as temperature, salinity, dissolved oxygen, pH, nutrient concentrations are known to control the diversity, distribution and activities of microorganisms in the environment (Mahalakshmi *et al*., 2011). The two sampling periods (April and July) typically represents two different seasons and consequently different environmental factors and effects on the microbes. The fin fishes *Shyraena piscatorum* (Baracuda), *Chrysichthys nigrodigitatus* (Silver cat fish) and the shell fishes *Penaeus notialis* (pink shrimp) and *Callinectes sp*. (crab) in this study are among the commonly caught and commercially important seafood in Nigeria coastal area (Bolarinwa *et al*., 2018). They serve as a regular source of protein to the general public and there is a growing preference for fresh seafood. It is therefore pertinent that the presence of pathogenic and potential pathogenic bacteria in these fish samples should serve as an alert to consumers. There is risk of bacterial infection if seafood is not well cooked and immune-compromised individual including pregnant women, the elderly and persons with underlying medical condition are at a higher risk.

Conclusion

The occurrence of coliform and pathogenic bacteria in finfish and shell fish from the coastal waters in Lagos and Ondo state of Nigeria further indicates the pollution status of our aquatic ecosystem, and the threat it poses on our natural fishery resources. There is an urgent need for increased awareness of the possible effect of the consumption of these seafood and also improvement on the handling of fish from capture to the point of sale.

Acknowledgment

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Length Weight Relationship and Condition Factor (K) of three Fish Species of *Carangidae* Trawled from Nigerian Coastal Waters

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Abstract
The growth pattern and condition factor for three species of family Carangid trawled from Nigeria coastal water were investigated recently. A total of 720 specimens ranging from 4.0 to 35.0cm in total length and 0.8 to 540.0g in weight were analyzed. Total length and weight were measured using standard methods and computed from linear regression. The growth pattern relationship is shown by the following equation: LogW = -1.6759+2.7615LogL (Selen dorsalis), LogW = -1.327+2.3448LogL (Chloroscombus chrysurus) and LogW = -2.1215+3.1468LogL (Caranx hippos). Selen dorsalis and Chloroscombus chrysurus exhibited negative allometric growth (b<3) while Caranx hippos was positively allometric growth with b=3.14 and the mean b= 2.75. The correlations (R^2) were 0.9071, 0.8977 and 0.8629 for Selen dorsalis Chloroscombus chrysurus and Caranx hippos respectively. The condition factor (k) ranged from 0.77±0.14 (Caranx hippos) to 5.04±3.4 (Chloroscombus chrysurus). The best condition factor was recorded for those individual within the lowest size groups. Most of the species studied are not in good condition (k≤1)
Keywords: Carangidea, Length weight relationship, Condition factor, and Nigerian coastal waters

Introduction
The family Carangidae encompasses a diverse group of fishes known variously by such common names as jacks, trevallies (crevalles), amberjacks, pompanos, scads, kingfish, pilot fish, rainbow runners among others (Randy, 2001). The length – weight relationships (LWRs) is of great importance in fishery assessment (Garcia *et.al.*. 1998; Haimovici and Velasco, 2000). Its importance is pronounced in estimated the average weight at a given length group (Beyer, 1987) and in assessing the relative wellbeing of a fish population (Bolger and Connoly, 1989).Length and weight measurement in conjunction with age data can give information on the stock composition, age at maturity, life span, mortality, growth and production (Beyer, 1987, Bolger and Connoly, 1989, King, 1996 a and b, Diaz *et. al*., 2000).In addition, the data on length and weight can also provide important clues to climatic and environmental changes and the change in human consumption practices (Ecoutin et.al., 2005, Pauly 1984). However, the size attained by the individual fish may also vary because of variation in food supply of nutrient or in the degree of competition for food. Environment deterioration, for example, may reduce growth rates and will cause a decrease in the average age of the fish. The condition factor and the relative condition factor (Le. Cren, 1951) are the quantitative parameters of the wellbeing state of the fish and reflect recent feeding condition of the fish. It is based on the hypothesis that heavier fish of a given length are in better condition (Bagenal and Tesch, 1978). This factor varies according to influences of physiological factors, fluctuating according to different stages of the development. Condition factor has been used as an index of growth and feeding intensity (Fagade, 1979). Condition factor decrease with increase in length (Bakare, 1970: Fagade 1979) and also influences the reproductive cycle in fish (Welcome, 1979). The aim of this research is to study the length-weight relationships and the variations in the condition factor among five species of sciaenid population trawled from Nigeria coast water.

Materials and Methods

Study Area

The sampling areas started from Nigeria/Benin boarder to the Western part of Ondo State. Eleven transects were sampled with seven stations on each transect line. The seven stations selected were based on the depth ranges; 10, 20, 30, 40, 50, 70 and 100m. The distances between transects was 5 nautical miles (9.26km) apart and the total distance between first and last transect was 50 nautical miles (92.6km) (Figure 1).

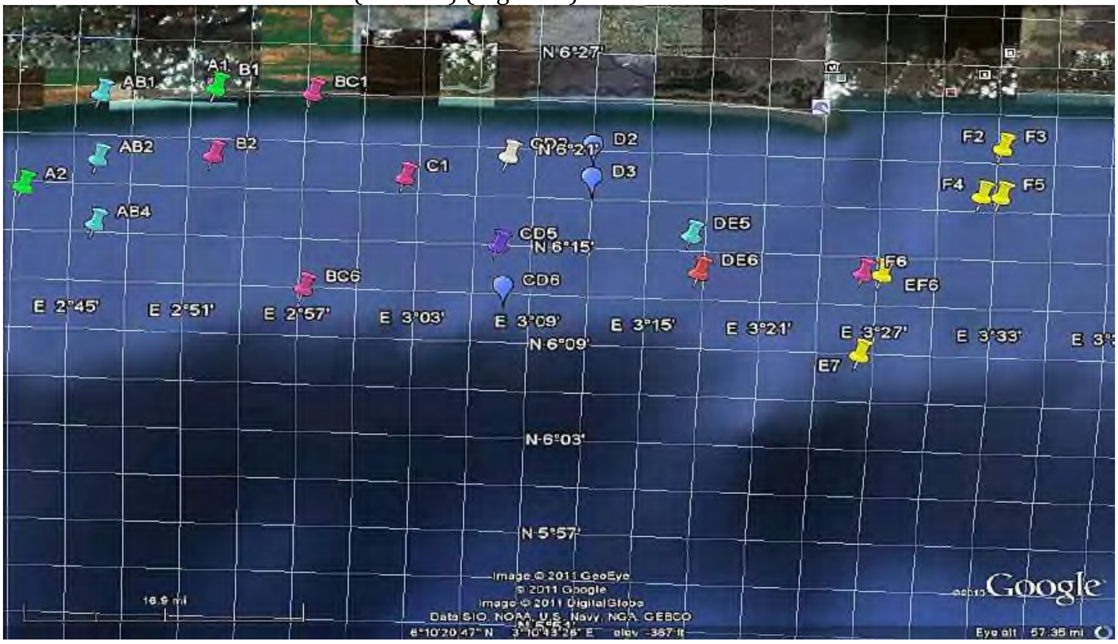

Figure 1: Map of Nigeria coastal water showing sampling stations

Fish Sampling

Fish were collected with a trawl net (cod-end 20mm mesh size), trawled at different depth, ranging from 10m-100m between May and June 2009. These species were abundant in 50m depth and above. The Total Length (cm) of the fish was measured from the tip of the snout or part of the mouth to the caudal fin using meter rule calibrated in centimeters. Fish was measured to the nearest centimeter. The weight of the fish was done with a table top weighing balance (Ohus Electronic) measured to the nearest gram. Fish weight was measured after blot drying with a piece of clean hand towel.

Length-weight Relationship

The relationship between the length (L) and weight (W) of the fish was expressed by equation (Pauly, 1984)

$$W=aL^b \qquad \text{Equation 1}$$

Linear transformation was made using natural logarithm at the observed length and weight proposed by Zar (Zar, 1984). The expression of the relationship is represented by the following formula:

$$\text{Log } W = b \log L + \log a \qquad \text{Equation 2}$$

Where: W = the weight of the fish in gram
L = the total length of the fish n centimeter
a = exponent describing of the rate of change of weight with length (intercept)
b = weight and unit length (slope)

The correlation (r^2) that is the degree of association between the length and weight was computed from the linear regression analysis:

$$R = r^2$$

Condition Factor

The degree of well being or relative robustness of the fish is expressed by coefficient of condition (also known as condition factor or length – weight factor). The condition factor as an indicator to fish welfare in their habitat was described (Gomiero and Braga, 2005). It is represented by letter K (formula 2) when the fish is measured and weighed as in the following equation (Pauly, 1984). This "k" value can be basically and directly interpreted as the higher the value, the better the condition of the fish.

$$K = \frac{100W}{L^b} \qquad \text{Equation 3}$$

Where: K = condition factor

W = the weight of the fish in gram

L = the total length of the fish in centimeters

b = the value obtained from the length weight equation in this study, the exponent

'b' value that is equal to 3 in equation 3 was used to calculate the 'k' value.

The K value is used to compare conditions between species and within their size classes (<5-9cm, 10-14cm, 15-19cm, 20-24cm, 25-29cm 30-34cm 35-39cm 40-44cm 45-49, TL etc).

Results and Discussion

A total of 720 fish were analyzed, 387 for *Selen dorsalis*, 298 for *Chloroscombus chrysurus* and 35 for *Caranx hippos*. The descriptive statistics for total length (TL) and weight (W) of the three species of Carangid were showed in Table 1.The total lengths (TL) of 720 specimens of three species of carangid examined in this study ranged from 4.0 (*Selen dorsalis*) to 35.0cm (*Caranx hippos*) while the weight ranged from 0.8 (*Selen dorsalis*) to 540.0g (*Caranx hippos*) (Table 1). The length weight patterns (GPs) of three species of carangid were showed in Table 2. Length weight relationships are shown by following equations: LogW = -1.6759+2.7615LogL (*Selen dorsalis*), LogW = -1.327+2.3448LogL (*Chloroscombus chrysurus)* and *LogW* = -2.1215+3.1468LogL (*Caranx hippos). Selen dorsalis* and *Chloroscombus chrysurus* exhibited negative allometric growth (b<3) while *Caranx hippos* was positively allometric growth with b=3.14 and the mean b= 2.75. The correlations (R^2) were 0.9071, 0.8977 and 0.8629 for *Selen dorsalis Chloroscombus chrysurus* and *Caranx hippos* respectively (Table 2 and Figures 2 - 4). In all the species the correlation coefficient found to be higher than 0.5, showing the length-weight relationship is positively correlated and vice versa. The condition factor (k) ranged from 0.77+0.14 (*Caranx hippos*) to 5.04+3.4 (*Chloroscombus chrysurus*) with mean value of 2.69+1.64. There was a general decrease in condition factor (K) with increase length for the five species (Table 3).

Table 1: Means of Length and Weight for the Three Fish Species of Carangid Trawled from Nigerian coastal waters

Species	N	Average length(cm)	Length range(cm)		Average weight(g)	Weight range(g)	
			Max	Min		Max	Min
Selen dorsalis	387	11.55	32.0	4.0	25.57	394.8	0.8
Chloroscombus chrysurus	298	13.89	22.0	5.0	25.54	98.5	1.4
Caranx hippos	35	22.83	35.0	18.0	162.54	540.4	37.6

N = Number of species, Max = Max, Min = Minimum

Table 2: Length Weight Relationship for the Three Fish Species of Carangid Trawled from Nigerian coastal waters

Fish Species	b+s.d	Logarithmic equation	R^2	K
Selen dorsalis	2.76 ± 0.37	LogW = -1.6759 + 2.7615LogL	0.9071	2.28 ± 1.29
Chloroscombus chrysurus	2.34 ± 0.38	LogW = -1.3270 + 2.345LogL	0.8977	5.04 ± 3.45
Caranx hippos	3.14 ± 0.45	LogW = -2.1215 + 3.1468LogL	0.9287	0.77 ± 0.14

N = number of fish; b = regression co-efficient; R^2 = correlation co-efficient; K = Condition factor

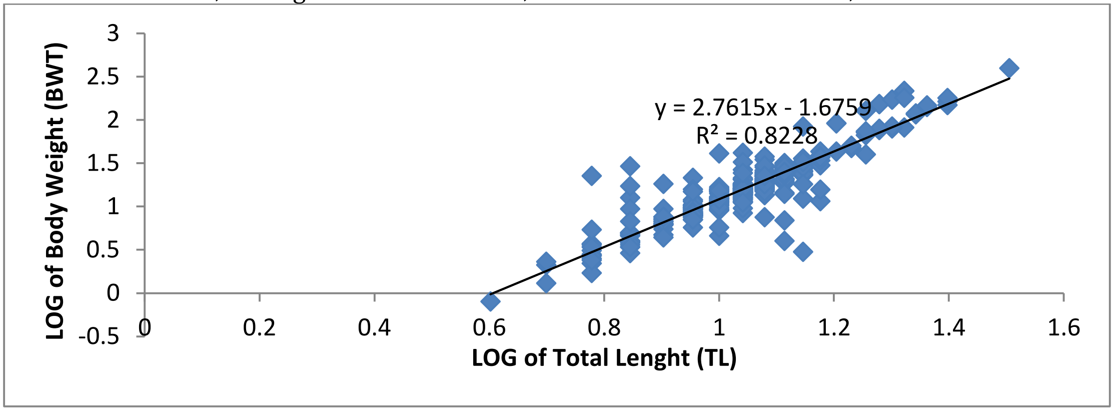

Fig. 2: Linear regression of total length-body weight relationship of *Selen dorsalis*

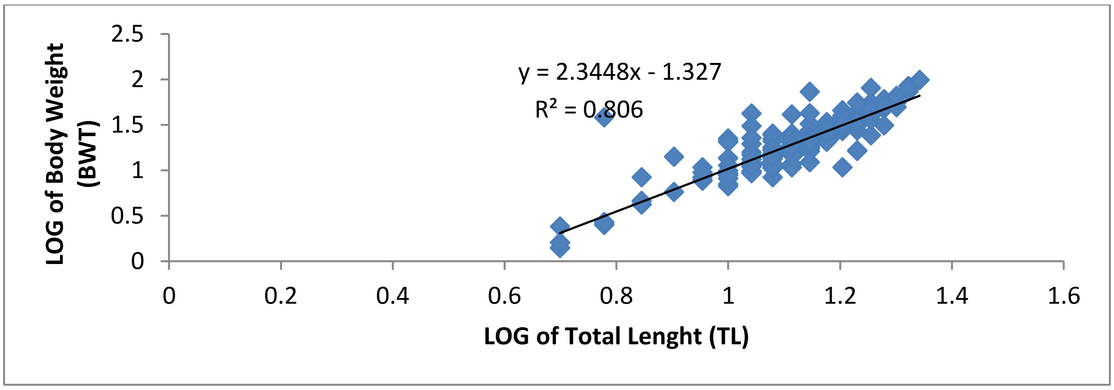

Fig. 3: Linear regression of total length-body weight relationship of *Chloroscombus chrysurus*

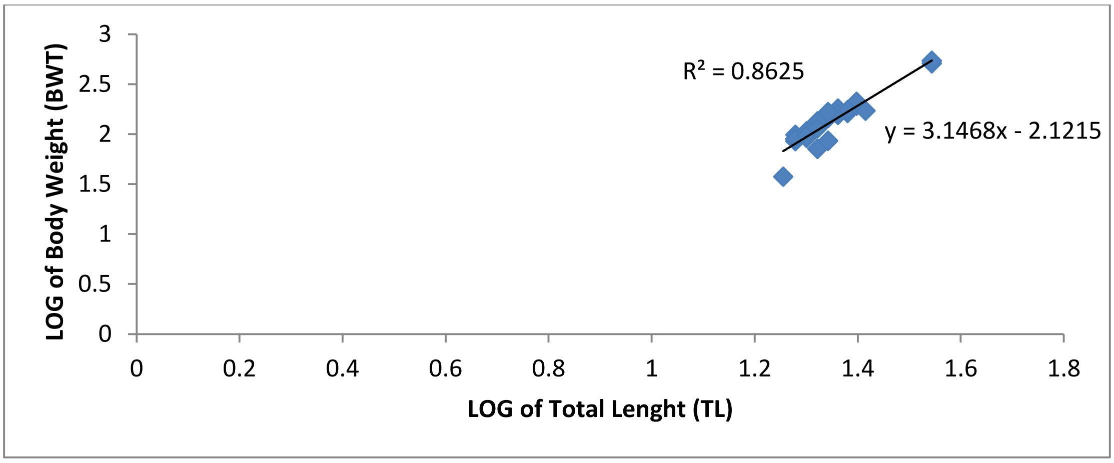

Fig. 4: Linear regression of total length-body weight relationship of *Caranx hippos*

Length-weight relationship: Length-weight relationship gives information on the condition and growth patterns of fish (Bagenal and Tesch, 1978). Fish are said to exhibit isometric growth when length increases in equal proportions with body weight from constant specific gravity. The regression co-efficient (b) for isometric growth is "3" indicates positive allometric growth which indicates that fish becomes heavier for a particular length as it increases in size (Gayando and Pauly, 1997, Wotton, 1998 Zafar *et al*.. 2003). The "b" values for *Selen dorsalis* and *Chloroscrombus chrysurus* showed a negative allometric growth, only *Caranx hippos* that showed a positive allometric growth (Table 2). According to Parsa *et al* (2017) the valves of exponents "b" usually ranges between 2.5 and 2.9. Several authors have both reported isometric and allometric growth for different fish species from various water bodies. Pauly and Gayando (1997) reported that b values may range from 2.5 to 3.5 which support the result of this study.

Thulasitha (2012) recorded "b" value of 2.64 for *Scomberoides lysan* which of the same family with this present studies. Barthelemy *et al*. (2014) reported b values ranged between 2.8 and 2.9 for family carangidae in Aby Lagoon, Southeastern Cote d'Ivoire. Sudekum *et al*. (1991) also reported the value ranged between 2.30 (Caranx ignobilis) and 2.86 (*Caranx melampygus*) from oceanic community, Hawaii. In the present study, for the length-weight relationship of carangids, weight increased proportionately to an increase in length in all the species. Correlation coefficients (R^2) were very high and highly significant which is an indication that changes in total length and weight of these fish species were directly proportional. The length weight relationship in fishes is affected by a number of factors including season, habitat, gonad maturity, sex, diet and stomach fullness, health and preservation techniques (Tesch. 1971) which are not reported in this study.

The condition factor (K): individual fish species condition are determined based on the analysis of length weight data reflected that the heavier fish at a given length is in better condition (Borgal *et.al.,* 1989) K also gives information when comparing two populations living in certain feeding density, climate and other condition (Bagenal and Tesch 1978). The condition factors ranged obtained from this study varied slightly with the result from other studies. Abowei (2010), reported the mean condition factors ranging from 0.941 – 0.985 for five fish species from Nkoro River, Nigeria although not of the same species. The values obtained from this study showed that all species studied were in good condition. Braga (1989) showed that the values of the condition factor vary according to seasons and are influenced by environmental condition. The same may be occurring in the environment under this study since Nigeria coast is influenced by many biotic and abiotic factors which favor the equilibrium of all the species in an ecosystem. Mgbenka and Eyo (1992) and Fawole (2002) attributed the difference iin condition factor to the deposition of materials for gonad formation, which led to increase in weight and actual spawning which lead to reduction in fish weight respectively. In addition, Vazzoler (1996) confirmed that lowest k values during the more developed gonadal stage might mean resource transfer to the gonads during the reproductive period.

Conclusion

The present investigation on length-weight relationships and condition factor of scieanids from Nigerian coastal water indicates that the condition is not quite satisfactory with the exception of the lower class sizes in the Nigerian coast. Again, information worldwide has shown that there is unrestricted use of marine resources and the consequent decline in the stocks. It is therefore the responsibility of the scientists and fisheries research institutes to provide scientific data and the management plan for marine resources especially for the Nigerian coast.

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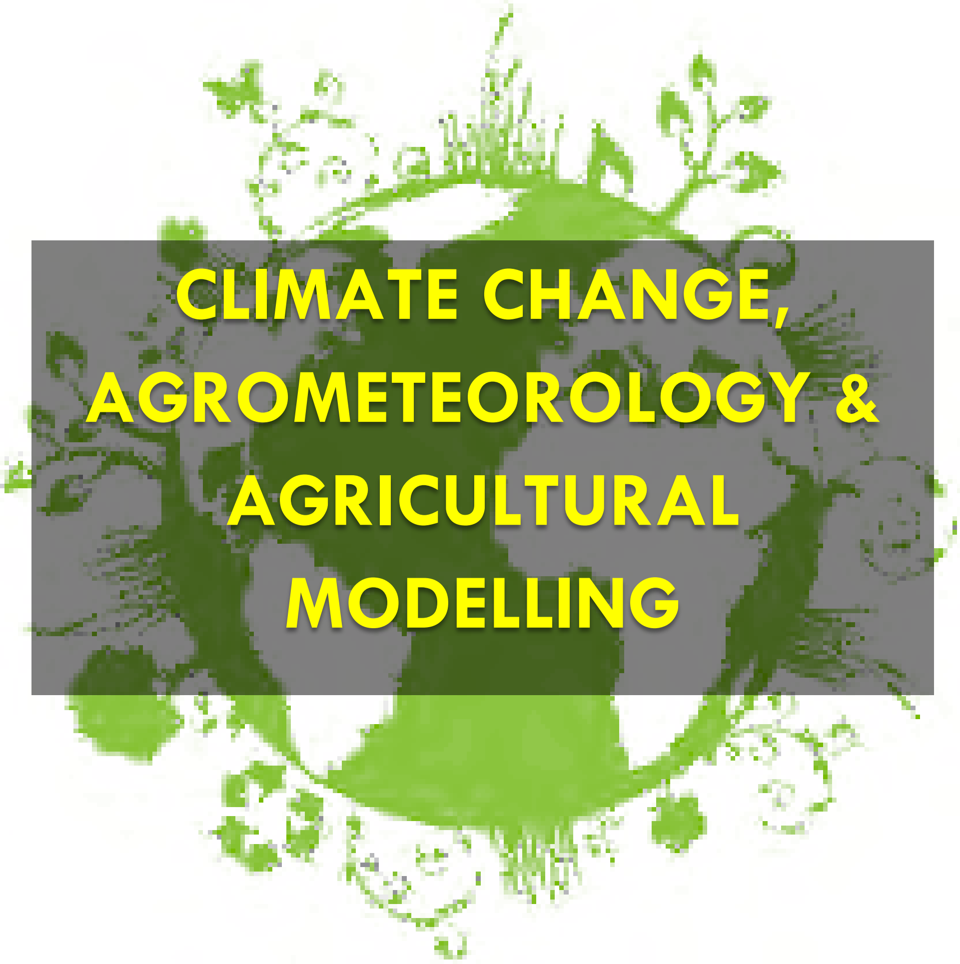
SUB-THEME 7

CLIMATE CHANGE, AGROMETEOROLOGY & AGRICULTURAL MODELLING



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Climate Change on Root and Tuber Crops and Farmers' Coping Strategies in Nigeria

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Abstract
The effects and implications of climate change are well documented in literatures. This review work was aimed to add to the existing knowledge on climate change on coping strategies adopted by farmers to the effect of climate change on root and tuber crops. The work reviewed the farmers' coping strategies to the effect of climate change in Nigeria. Previous studies on climate change relating to causes of climate change and the coping strategies adopted by farmers' to mitigate the effect of climate change were reviewed. It was found that climate change occurs as a result of human activities, air pollutants and ocean-atmosphere variability. Farmers' adopted the following strategies to mitigate the effect of climate change; changing their cropping systems in response to climate change, adhering to root and tuber crops tolerance enhancement programme to stress outcome, diversification of crop uses and agricultural environment adaptation and management.
Keywords: Climate Change, Coping Strategies, Root and Tuber Crops

Introduction
The term "climate change" is often used to refer specifically to anthropogenic climate change (also known as global warming). Anthropogenic climate change is caused by human activity, as opposed to changes in climate that may have resulted as part of Earth's natural processes. (The AGW, 1993). In this context of environmental policy, the term climate change has become synonymous with anthropogenic global warming. Within scientific journals, global warming refers to surface temperature increases while climate change includes global warming and everything else that increases greenhouse gas levels effect (NRC, 2010). Climate change is arguably the most persistent threat to global environmental stability. Folland, Karland Salinger, (2006), reported a warming of approximately 0.7'C over most of the African continent during the 20th century based on historical records. Smith *et al,* (2000), see coping strategies to climate change simply as a response to concerns about climate change. Coping strategies to climate change has been viewed by others as a long term phenomenon being that when farmers using traditional techniques of agricultural production noticed that climate change altered, they need time to identify potentially useful strategies, learn, organize resource and implement them (Maddison, 2006). Coping strategies here refers to "the ability a (human) system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (FAO, 2009). The resources include those from farmers' own sources and those external to them; the later includes policy making and scientific knowledge systems (Yaro, 2013). Scientific knowledge encompass the use of new varieties crops and breeds of animals, integrated pest management, integrated soil fertility management principles and forest management. Coping strategies concern diversification and specialization which have observed as farm level response to climate change (Bradshaw et al, 2004). Root and Tuber crops are vulnerable to the damaging effect of climate change, however if the changes take place gradually, it may be able to adapt. Sudden changes such as water shortages, increases in crop damage as a result of new unpredictable changes in interaction among crops, weeds, insects and diseases or pathogens could have drastic effect (Ogbonna, *et al.* 2017). With varying changes in root crop yields in Nigeria and these crops being

the main staple food in low income. This review sought to assess the farmers coping strategies to the effect of climate change on root and tuber crops; cassava, cocoyam, sweet potato, yam production etc in Nigeria. Options for responding to these changes are few, but then effective policies can minimize the climate impact on food production.

Methodology

The study is a review of farmers' coping strategies to the effect of climate change. Literatures of previous studies on climate change were reviewed. Information were collected from scholarly published articles in books, journals and proceedings

Results and Discussion

Causes of Climate Change

Changes in the usual timing of rainfall or temperatures can affect the period when plants bloom and set to fruit, pollination of crops, food for migrating birds, water supplies for drinking and irrigation. On the broadest scale, the rate at which energy is received from the Sun and the rate at which it is lost to space determine the equilibrium temperature and climate of Earth. This energy is distributed around the globe by winds, ocean currents, and other mechanisms to affect the climates of different regions. Factors that can shape climate are called climate forcing or "forcing mechanisms". (Smith*, 2013*). Causes of climate change include the following among others

Human activity: The most single human activity that has large impact on climate is the burning of fossil fuels such as coal, oil and gas These fuels contain carbon and burning them produces carbon dioxide gas. The amount of carbon dioxide in the earth's atmosphere has increased to nearly50% and average global temperature appears to risen between 1^0 and 2^oF (Adiele *et al*, 2017).

Gases, such as water vapor, which respond physically or chemically to changes in temperature are seen as "feedbacks." Gases that contribute to the greenhouse effect include:

Ocean-Atmosphere Variability

The ocean and atmosphere can work together to spontaneously generate internal climate variability that can persist for years to decades at a time.

Effects of Climate Change on Root and Tuber Crop Production

This Update focuses on two primary factors that have affected and will continue to affect crop production in the coming decades: rising temperature and relative humidity. Here, we briefly discuss the various mechanisms by which each of these impacts crop physiology.

Temperature affects yields through five main pathways

First, higher temperature cause faster crop development and thus shorter crop duration, which in most cases is associated with lower yields (Stone, 2001). Second, temperature impacts the rates of photosynthesis, respiration, and grain filling. Warming during the day can increase or decrease net photosynthesis (photosynthesis-respiration), depending on the current temperature relative to optimum, whereas warming at night raises respiration costs without any potential benefit for photosynthesis. Third, warming leads to an exponential increase in the saturation vapor pressure which causes oxidative damage to photosynthetic machinery in all major crop plants (Wilkinson *et al*., 2012).

Relative humidity has remained roughly constant in recent decades over large spatial scales (Willett *et al*., 2007) and is projected to change minimally in the future as well. Increased VPD leads to reduced water-use efficiency, because plants lose more water per unit of carbon gain Plants respond to very high VPD by closing their stomata, but at the cost of reduced photosynthesis rates and an increase in canopy temperature, which in turn may increase heat-related impacts. An increased incidence of agricultural **drought** will increase crop water stress.

Coping Strategies to the effect of climate change

Cropping Systems and Crop-Specific Responses to Global Change

According to David and Sharon (2012), global change factors will have varying impacts on cropping systems around the world, due to regional differences in rates of daytime and night time warming, changes to the timing, frequency, and intensity of precipitation, and exposure to ozone and air pollution sources. Most aspects of farm management, such as the specific crops grown and level of inputs, also differ considerably by region and play an important role in shaping the impact of weather and climate change. Farmers are also likely to change these practices in response to climate change, for instance by sowing different crops or varieties, changing the timing of field operations, or expanding irrigation, and the socioeconomic capacity to make these adaptive changes will differ by region. Even atmospheric CO_2 increases, which will be uniform around the world, will have regionally disparate effects because of different mixtures of crop types and moisture conditions

Root and Tuber crops tolerance enhancement programs to stresses

Improving crop tolerance to abiotic stress and its utilization and exploiting new uses of local food crops varieties (Root and Tuber crops)

Eco- friendly cropping systems and indigenous root and tuber utilization

Integrating Eco- friendly rotation systems for specific locations; Optimizing prevention and recovery techniques to reduce crops damage from stresses; Better storage and transport methods to reduce losses of harvested produce;

Farming and networking databases containing information related to rehabilitation farming

Agricultural environment adaptation and management

Combining cultivation practice and management techniques before and after extreme weather events to reduce losses; Adjusting farming practice and crop variety to reduce emission of greenhouse gases; ncreasing soil carbon storage with improved crop and land management (Chwen- MingYang, 2016)

Conclusion

The study reviewed the farmers' coping strategies to the effect of climate change in Nigeria. Previous studies on climate change relating to causes of climate change and the coping strategies adopted by farmers' to mitigate the effect of climate change were reviewed. It was found that climate change occurs as a result of human activities, air pollutants and ocean- atmosphere variability. Farmers' adopted the following strategies to mitigate the effect of climate change, such as changing their cropping systems in response to climate change, adhering to root and tuber crops tolerance enhancement programme to stress outcome, diversification of crop uses and agricultural environment adaptation and management. It is hoped that with these strategies the effect of climate change on root and tuber crops will be reduced in Nigeria.

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Micro-Analysis of Adoption of Adaptation Technologies to Climate Change by Arable Crop Farmers in Umuahia Agricultural Zone of Abia State, Nigeria

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Abstract
This study was conducted in Umuahia Agricultural Zone of Abia State, Nigeria. The study examined the socio-economic characteristics of the respondents, identified the adaptive technologies adopted, levels of adoption and determined the factors that influenced the level of adoption of adaptive technologies at farm-level in the study area. A multi-staged sampling technique was used to select 120 arable crop farmers. Data were collected through primary sources. The collected data were analysed with descriptive statistics, likert scale and tobit regression analysis. The result showed that the major adaptive technologies used by the farmers include; mulching, multiple/inter cropping, change in planting/harvesting dates, cover cropping, crop diversification, land fragmentation, soil and water conservation techniques and non-farming activities. The result also showed that out of fifteen adaptive technologies identified in the study area, the level of adoption was high in six technologies and low in nine technologies respectively. The findings indicated that education, membership of cooperative society, farm size, farm income and access to credit positively and significantly affected the adoption of adaptive technologies while age and household size inversely affected the adoption of the adaptation strategies to climate change. The farmers are therefore, encouraged to be planting trees, and participate in insurance scheme because presence of trees help immensely in moderation of effect of climate change and participation in insurance scheme help to protect the farmers from the uncertainty of climate change. Policy should aim at intensification of extension education to increase the farmers' knowledge about climate change and the ways of ameliorating its effect.
Keywords: Climate change, Adaptive technologies and Adoption

Introduction
In recent years, climate change is one of the challenging issues that are confronting the world at large. Climate change is a change that is attributed directly or indirectly to human activities which alters the composition of the global atmosphere and in addition to natural climate variability observed over comparable time periods (UNFCCC, 2007). In the developing countries, it is affecting pattern of life and general living conditions of people which include availability of water, food production, weather condition, health, culture, economic well-being and recreation among others. West African sub-region is acknowledged to be one of the areas that is most vulnerable to the vagaries of climate change (IPCC, 2007). In the region, most of the agricultural production system is rain-fed; the rural populace depends on streams and rivers for their water usage, forest and grassland for energy and the environment for other livelihood activities. Any change in climate affects the socio-economic activities of the people. This leads to impending catastrophe such as drought, drying of streams, irregular rain fall patterns, rise in sea level, flooding, heat stress and outbreak of newly formed diseases among rural communities whose activities are farming and livestock production (Ibrahim *et al*., 2016). In view of all these problems of climate change, farmers need to adopt adaptation measures in order to cope with the effect of the climate change. The adaptation lessens the adverse effects and takes advantage of benefits of change in climate variables (Ndaman and Watanabe, 2017). The adaptation is an

adjustment or intervention which takes place in order to manage the loses or take advantage of opportunities presented by changing climate (IPCC, 2001). It is the process of improving society's ability to cope with changes in climatic conditions across time scale, from short-term (seasonal to annual) to the long-term (eg decades to centuries) (Okezie and Simonyan, 2011). Adaptation occurs at two main scales: (a) the farm-level that focuses on micro-analysis of a farmer decision making and (b) the national level or macro-level that is concerned about agriculture at national and regional scales and its relationship with domestic and international policy (Bradshaw *et al.*, 2004; Kandlinkar and Risbey, 2000). Micro-level analysis of adaptation focuses on tactical decisions farmers make in response to seasonal variations in climate, economic and other factors (Okezie and Simonyan, 2011). This study therefore, focuses on the micro or farm level analysis of adaptation technologies adoption. These adaptation technologies are practiced by Nigerian crop farmers in order to reduce the effect of climate change which include intensification of irrigation, crop diversification, multiple/intercropping, agro-forestry/afforestation, mulching, use of new crop varieties, increased seed rate, crop rotation, tree planting, mixed cropping system, changing planting dates and use of family labour (Anyaoha *et al.*, 2008; Enete *et al*., 2011; Hassan and Nhemachena, 2008; and Owombo *et al*., 2014). In the South eastern Nigeria, most of the crop farmers are arable farmers who are invariably smallholder farmers. These farmers are characterized by use of small land that is not more than five hectares, use family labour, lack necessary inputs; depend on their farms as their main source of food security and income. They are involved in the production of arable crops such as cassava, yam, maize, rice, melon etc (Awoke and Okorji, 2004 and Eze, 2007). These people's activities are vulnerable to climate change because they depend on weather and any change in temperature and rainfall directly affect their crop productivity as well as crop output, income and well-being. In order for these farmers to reduce the adverse effect of the climate change, they need to go into adoption of adaptation practices such as mulching, crop diversification, crop rotation etc to enable them moderate the vulnerability of the climate change and survive in their enterprises. The adoption is simply the decision to start using something like new ideas, new technologies or innovation. It is a decision to continue full use of an innovation or mental process which an individual passes through in deciding to use an innovation (Orebiyi *et al.*, 2006). In the decision making, the farmers assess the benefit and possible disadvantages. In the study area, response to climate change through adoption of adaptation measures appears to be weak. It seems that there is a gap between the rate at which climate is changing and the response to reduce its effect through the use of adaptation technologies that ensure sustainable food security by the arable crop farmers. The gap on the adoption to the climate change adaptation technologies has subjected the farmers to the vagaries of climate change such as high intensity of heat for prolonged period of time, drought, and flood, low crop yields, etc. Experience at the farm level on how rural arable drop farmers perceive these changes and how they are responding to the effects of the climate change are limited. Studies on adaptation strategies to climate change at the regional and national levels had been conducted but none seem to have been conducted in Umuahia agricultural zone of Abia State which would impact knowledge to the farmers and help them reduce the effects of the climate. Hence considering this knowledge gap, the researchers deemed it necessary to carry out this study at the farm-level in order to examine the adoption of adaptive technologies to climate change by arable crop farmers in Umuahia agricultural zone of Abia State. Hence the study seeks to identify the adaptation technologies adopted, the level of adoption and determine the factors that influence the level of adoption of the adaptive technologies to climate change at the farm level in the study area.

Materials and Method

The study was conducted in Umuahia Agricultural Zone of Abia State in the South east of Nigeria. Abia state is made up of three agricultural zones, namely; Aba, Ohafia and Umuahia. Umuahia zone consists of five Local Government Areas (LGAs). The zone is located between latitudes 5^0 $49^/$N and 6^0 $92^/$ N of the Equator and Longitudes 7^0 $23^/$ E and 8^0 $02^/$ E of Greenwich meridian. First, three LGAs out of five that make up the zone were randomly selected. Secondly, two autonomous communities were randomly chosen from each LGA selected, making it six communities that were chosen. Thirdly, from each autonomous community chosen, one village was randomly selected, and then lastly, from each of the village selected, 20 arable crop farmers were randomly selected, now making it a total of 120 respondents that were used for the study.

Data were collected from primary sources through the use of structured questionnaire designed to elicit information from the respondents. Extension agents in the located area of the study assisted the researchers in the administration and collection of the questionnaire. The data collected were analysed by using descriptive statistics, Likert scale and Tobit regression analysis. The adaptation technologies adopted by the farmers were analysed with descriptive statistics while the level of adoption of the technologies was analysed using Likert scale. The rating scale was used to determine level of adoption of the respondents. A three point Likert scale was adopted. The scale is given as 1 = No adoption, 2 = Low adoption and 3 = High adoption. The mean of adoption was calculated as follows:

$$XS = \frac{\sum X}{N} \quad (1)$$

Where: X = Weight on scale, N = Total number of weight, $\sum$ = Summation

Therefore, the mean $(\overline{X}) = \frac{1 + 2 + 3}{3} = 2.0$ (2)

The mean score of each technology was computed by multiplying the total number of responses for a particular technology with the weight attached to the response chosen and then divided by the total number of respondents.

That is $XS = \frac{\sum fn}{N}$ (3)

Where: f = number of responses, n = weight attached to scale, N = total number of respondents. The rating was carried out thus; technologies with adoption score of above 2.00 was considered high level of adoption, while the ones with ≤ 2.00 were regarded low level of adoption respectively.

To determine the factors that influence the factors that influence the adoption of adaptation technologies to climate change, Tobit regression analysis model was used. The Tobit decomposition framework examined the effect of changes in the explanatory variables (Xs) on the probability of adopting measures to adapt to climate change by the arable crop farmers (Mailum *et al*., 2016). The tobit model is expressed thus:

$$V_1 = \beta Xi + Ui$$

If $V_1 > V_1^*$, $V0 = \beta Xi + Ui$ if $V_1 \leq V_1^*$ (4)

Where V_1 is the number of respondents, V_0 is the limited dependent variable, it is discrete if the farmers do not adopt climate change adaptation technologies (it assumes zero value in this case) and continues if they adopt ie equal to V_1^*, $V_1^* > 0$, it implies that V_1 is observed, $V_1^* \geq 0$, implies that V_1 is not observed, X_1 is a vector of explanatory variables, β is a vector of unknown coefficient and Ui is an independently distributed error term. The model explicitly used in determining the factors influencing the adoption of adaptation technologies to climate change is as follows:

$$Vi = \beta 0+\beta_1X_1+\beta_2X_2 +\beta_3X_3 +\beta_4X_4 +\beta_5X_5 +\beta_6X_6 +\beta_7X_7 +\beta_8X_8 +\beta_9X_9 +\beta_{10}X_{10} +\beta_{11}X_{11} +Ui$$

Where X_1 = Household size (Number), X_2 = Age of household head (Years), X_3 = Educational attainment (Years), X_4 = Membership of cooperative society (Dummy, Member = 1, Non- member = 0), X_5 = Climate change awareness (Dummy, Aware = 1, Not aware = 0), X_6 = Farm size (Ha), X_7 = Access to information (Dummy, Access = 1, No access = 0), X_8 = Extension contact (Number), X_9 = Tenure security (Dummy, Ownership = 1, Not owner = 0), X_{10} = Farm income (N), X_{11} = Access to credit (Dummy, Access = 1, No access = 0), Ui = error term.

Results and Discussion

Adaptation Technologies Adopted by the Respondents in the Study Area

Table 1 shows the adaptation technologies adopted by the arable crop farmers in order to reduce the effect of climate change in the study area. The Table shows that majority (86.7%) of the farmers adopted multiple/intercropping and 85% mulching to reduce the adverse effect of climate change. This result supports the findings of Ibrahim *et al*., (2016) who noted that multiple/intercropping and mulching were the most dominant strategies of adoption of adaptive technology measures that farmers used in their study to reduce the effect of climate change. The use of mulch could be that the farmers used it to prevent much evaporation of water from soil especially during heat period in order to retain moisture in the soil. Change in planting and harvesting dates were adopted by 71.7% of the respondents while 76.7% of the farmers fragmented their land by having good number of plots to guard against the effect of climate change. Also 73.3% of them used cover cropping technology. More so, 54%, 55% and 50.8% practiced soil and water conservation technique, increased size of mound/ridge and crop diversification as ways of reducing the adverse effect of climate change. Conversely, crop rotation, shedding/sheltering and agro-forestry and insurance cover were practiced by 39.2%, 10%, 16.7% and 8.3% of the arable crop farmers respectively to ameliorate the effect of the climate change. These findings confirm the results obtained by Enete *et al*., 2011; Anyoha *et al*., 2013; Hassan and Nhemachena, 2008 and Owombo *et al*., 2014 in their various studies carried out in different parts of Nigeria.

The Level of Adoption of Adaptation Technologies to Climate Change in the Study Area
Table 2 shows the level of adoption of adaptation of technologies to climate change. The mean of the likert scale was 2.00. Therefore, any technology in the Table whose mean score is above 2.00 was considered high adoption while the one with ≤ 2.00 was regarded low level of adoption respectively. From the Table, it could be seen that out of 15 technologies, only six were at high level of adoption, these include mulching (2.37), multiple/intercropping (2.31), crop diversification (2.22), land fragmentation (2.15), cover cropping (2.08) and change in planting/harvesting dates (2.05) respectively. Conversely, the respondents had low level of adoption in the following technologies; fallowing (1.32), off-farm employment/non-farming activities (1.63), soil and water conservation techniques (1.88), change in the size of mounds/ridges (1.95) and crop rotation (1.73),irrigation practices (0.97), shedding/sheltering (0.59), agro-forestry/tree planting (0.80) and insurance scheme respectively.

Factors that Influence the Adoption of Adaptation Technologies to Climate Change
The result of factors that influence the adoption of adaptation technologies to climate change is shown in Table 3. The result of the tobit regression analysis showed that the likelihood was 462.45 and Chi-square (X^2) was 122.8. This shows that they were highly significant ($P < 0.000$) suggesting that the model has a strong explanatory power. This implies that those factors included in the model greatly influenced the adoption of climate change adaptation technologies at farm-level in the study area. Six out of eleven factors significantly influenced the adoption of climate change adaptation technologies. Out of these factors, education, membership of cooperative society, farm income and access to credit positively and significantly influenced the adoption of climate adaptation strategies in the study area. This implies that a unit increase in educational level, membership of cooperative society, farm income and access to credit will increase the adoption of adaptation strategies by 2.0308, 1.725, 2.5412 and 2.37 respectively. The positive influence of education on adoption of the adaptative practices shows that as the farmers move from one level of education to another, their probability of adopting technologies, innovations to climate change increases. This result is in line with the study of Deressa *et al*., (2008) who reported that education had positive relationship with adaptation strategies to climate change in Nigeria. The direct relationship of membership of cooperative society implies that participation in cooperative society increases the adoption of climate change adaptation strategies because the cooperative helps the farmers to be united, share knowledge and innovative ideas and become aware of the effect of climate change. Also positive and significance of access to credit implies that this factor has positive effect on adoption of adaptation technologies to reduce the effect of climate change because access to credit empowers farmers to undertake adoption of adaptative practices to climate change (Otti, 2016). Income also has similar effect as the other factors above and in consonance with *a priori* expectation. On the other hand, age and household size were negative and significant at 5% and 1% levels respectively. This implies that as the age and household size of the farmers' increase it probably leads to decrease in the adoption of adaptation measures to climate change. These findings corroborates with the result obtained by Mailumo *et al*., (2016)

Conclusion

The results showed that the major adaptive technologies used by the farmers to reduce the adverse effect of climate change were mulching, multiple/inter cropping, change in planting/harvesting dates, cover cropping, crop diversification, land fragmentation, soil and water conservation techniques and non-farming activities. The result further showed that out of fifteen adaptive technologies identified in the study area, the level of adoption was high in six technologies and low in nine respectively. The result also showed that education, membership of cooperative society, farm size, farm income and access to credit positively and significantly affected the adoption of adaptive technologies while age and household size inversely affected the adoption of the adaptive strategies to climate change. Therefore, farmers should be encouraged to plant trees, and participate in insurance scheme because presence of trees help immensely in moderating the effect of climate change and participation in insurance scheme help to protect the farmers from the uncertainty of climate change. Policy should aim at intensification of extension education to increase the farmers' knowledge about climate change and the ways of ameliorating its effect.

Table 2: Distribution of Arable Crop Farmers According to Adaptation Technologies Adopted in the Study Area

Adaptation Technologies	Frequency	Percentage
Multiple/Inter cropping	104	86.7
Land fragmentation	92	76.7
Fallowing	47	39.2
Irrigation practices	17	14.2
Crop diversification	61	50.8
Off-farm employment/non farming activities	54	45.0
Mulching	102	85.0
Cover cropping	88	73.3
Soil and water conservation techniques	65	54.2
Agro-forestry/tree planting	20	16.7
Shedding/sheltering	12	10.0
Increased size of mounds/ridges	66	55.0
Crop rotation	47	39.2
Change in planting and harvesting dates	86	71.7
Insurance coverage	10	8.3

Source: Field survey data, 2017. Multiple responses recorded

Table 3: Distribution Based on the Level of Adoption of Adaptive Technologies to Climate Change

Adaptive Technologies	High Adoption	Low Adoption	No Adoption	ΣX	$\overline{X}$	Level of Adoption
Crop diversification	50	46	24	266	2.22	High
Land fragmentation	50	38	32	258	2.15	High
Fallowing	22	29	35	159	1.32	Low
Irrigation practices	13	24	31	116	0.97	Low
Multiple/inter cropping	55	48	16	277	2.31	High
Off-farm employment/non farming activities	29	35	38	195	1.63	Low
Mulching	62	40	18	284	2.37	High
Cover cropping	44	42	34	250	2.08	High
Soil and water conservation techniques	35	37	46	225	1.88	Low
Agro-forest/tree planting	9	21	27	96	0.80	Low
Shedding/sheltering	6	15	23	71	0.57	Low
Increased in the size of mounds/ridges	38	38	44	234	1.95	Low
Crop rotation	33	34	41	208	1.73	Low
Change in planting/harvesting dates	32	60	30	246	2.05	High
Insurance coverage	3	11	24	55	0.46	Low

Note: High adoption = 2.00 and above, Moderate adoption = 1.00 - 1.99, Low adoption = 0.1 - 0.99
Source: Field survey data, 2017

Table 4: The factors that influence the adoption of adaptive technologies in the study area

Variable	Coefficient	Standard error	Z - test	p-value
Constant	7.952	2.9203	2.723***	0.005
Household size	-0.202	0.08196	-2.462**	0.042
Age of household head	-0.079	0.04047	-1.952*	0.064
Education	0.129	0.00965	2.0308**	0.041
Membership of cooperative society	1.2700	0.7364	1.725*	0.057
Years of climate change awareness	0.1917	0.5952	0.3220	0.456
Farm size	-0.130	0.169	-0.156	0.598
Average distance	-0.0640065	0.1087731	-0.59	0.556
Extension contact	0.0555	0.000155	-0.0550	0.988
Tenure security	0.570	0.0443	0.6271	0.711
Farm income	0.015	0.0610	2.5412**	0.037
Access to credit	0.1103	0.0465	2.37**	0.048
Wald chi-square (X^2)	122.83			
Prob > X^2	0.0000			
Pseudo R^2	0.1081			
Log seudo likelihood	-462.4476			

Source: Field survey data, 2017

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ASN 52nd Annual Conference Proceedings

Climate Change Awareness and Perception among Oil Palm farmers in Abia state, Nigeria

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Abstract
Public awareness, perception and knowledge on climate change constitute essential background to deal with climate change and related problems in the Oil Palm industry. This study examined farmers' general understanding of climate change in Ikwuano and Umuahia North LGA of Abia State, Nigeria. This research Study sort to find out Oil Palm farmers' perception of climate change variables, the level of awareness on Climate Change. Data were collected by use of structured questionnaire administered to 200 farmers randomly selected from eight communities in the study area. Descriptive statistics was used to analyze data obtained from the survey. Farmers (78%) in the study sample reported that they are well aware of the climate change while 22% percent of respondents had 'low' awareness level. A 4-point Likert type Scale was used to gauge farmers' response to questions posed in the questionnaire as regards perception on climate variables. Results also showed that the dominant perception of Oil Palm farmers on climate change variables, tend to be that temperature has been increasing (or is serious) in the study area. The paper concluded that high level of awareness will in the long run increase the adaptation potential of the community and make them less vulnerable towards climate change. Also Perception is necessary because only those Oil Palm farmers who perceive change in climate will decide whether to adapt to it or not.
***Keywords**: Awareness, Perception, climate change, oil palm farmers, climate variables, and Abia State*

Introduction
In Africa, climatic change is expected to, and in some parts, it has already begun to, alter the dynamics of droughts, rainfall and heat waves, and trigger secondary stresses such as the spread of pests, increased competition for resources, and attendant biodiversity losses (Enete and Amusa, 2010). Rapid changes in the behaviour of climate elements are expected to undermine the systems that provide for food security in Nigeria and Africa in general (Gregory *et al.,* 2005; Ojemade, 2016). Climate change has become a global issue of critical importance, increasingly acknowledged as one of the main challenges to sustainable development. Climate change impacts ecosystems, livelihoods, human security and socio-economic development of societies, and has been described as the 'defining human development issue of our generation' (UNDP, 2008). Climate variability and climate change have the capacity to reverse major achievements in human development across a range of sectors if not addressed properly and managed well. Gains in the health and education sectors, for example, could be affected by food insecurity and water scarcity. Climate change is therefore a core development issue because all human societies are dependent on climate for survival and prosperity. Nigeria is already experiencing the impacts of climate change, with more extreme weather events occurring, more variability in timing and intensity of rainfall and higher temperatures over the whole country (Abiodun, Salami and Tadross, 2011). Whilst farmers in some regions may benefit from longer growing seasons and higher yields, the general consequences for Africa (Mendelsohn *et al.,* 2000) are expected to be

adverse, and particularly more adverse for the poor and marginalized farm households, who do not have the means to withstand drastic changes. Evidence from the IPCC suggests that areas south of the Sahara are likely to emerge as the most vulnerable to climate change with likely agricultural losses ranging from 2 to 7%. A better understanding of how farmers' perceive changing climate and the awareness level of farmers is needed to formulate appropriate policies and programmes aimed at promoting successful awareness of farmers and adaptation strategies to cope up with climate change. Abia state which is part of Niger Delta region is already experiencing some important climate change related hazards such as, increased temperature (including seasonal changes), more intensive and frequent storms, sea level rise, more heat waves, more flooding and extreme floods and more extreme rains including seasonal changes (Okoh *et al.*, 2011), and a greater percentage of the population of Niger Delta region lives in the rural areas. Also the capacity of farmers to adapt to climate change can be significantly influenced by the level of awareness about climate change in their communities. In this regard, Tol (1998) suggested that awareness about climate change has great capacity to drive farmers to improvise local technologies to aid adaptation. Also, perception is determined by learning factors (Maddison, 2006) where indicators such as age, experience, environment and information on weather and climate play a very important role in the awareness of climatic parameters (Roncoli *et al*., 2002). Moreover, studies (Enete and Amusa, 2010; Mendelsohn and Dalfelt; Enete and Thorton,2011; Okoh *et al*,2011;Fonta et al,2011; Ozor and Cynthia, 2010) on the science of climate change, its effects and adaptation measures have received much attention but climate change education, awareness and perception of oil palm farmers on climate change, in the oil palm industry are given very little or no attention. In order to make insight into these issues, the present research study was undertaken to find out farmer's awareness about climate change, their perception about the indicators and /or variables of climate in the oil palm industry.

Methodology

This study was conducted in Ikwuano and Umuahia North Local Government Areas (LGAs) of Abia State Nigeria. The LGAs were purposively chosen because of intensity of oil palm cultivation. Ikwuano and Umuahia North LGAs are two of the five LGAs that constitute Umuahia Agricultural Zone of Abia State Nigeria. The LGAs are located within Latitudes 05030' N and 05040' North of the Equator and longitudes 07025' E and 07032' East of the Greenwich Meridian. Its population stood at 361,127 people who are predominantly rural farmers, of which 48.0% are females and 52.0% are males, on a land mass of about 521km2 (FRN, 2006). Farmers that predominate these areas produce food crops such as yam, cassava, plantain, banana, vegetables and cash crops such as oil palm, and cocoa. A Two Stage random sampling technique was adopted in the selection of panel of farmers involved in this study. First, 4 communities each, were randomly selected from the LGAs (Ikwuano and Umuahia North), making a total of 8 communities. In the second stage, 25 oil palm-based farm households were randomly selected from each of the chosen communities giving a total sample size of two hundred (200) oil palm farm households involved in this study. The sampling frame used was provided by the Agricultural Extension Agents (EAs) of the Agricultural Development Programme (ADP) serving in the study area. Instrument of data collection was a pre-tested structured questionnaire which was administered to Oil Palm farmers across sexes and their farming households by personal interview method. However ,out of the 200 questionnaires administered, the researcher was able to retrieve information from 172 respondents representing a response rate of 86.%. The analytical technique comprised the use of descriptive statistics which was used to collect information on awareness to climate change. Climate change as a variable was measured through proxy in form of perception of intensity of the climate change among oil palm farmers. Each component of climate (e.g. rainfall, temperature sunshine, and Humidity) had its perception scale (with Likert-type scale) to reflect seriousness of the change. The scale range is noted below:

Very serious	=	4
Serious	=	3
Less serious	=	2
Not serious	=	1

Results and Discussion

Farmers (78%) in the study sample reported that they are well aware of the climate change (Table 1). Further 22% of respondents had 'low' awareness level, . Raghuvanshi and Ansari (2016) reported that to cope up with climate change depends on level of awareness about climate change. Farmers who are aware about the climate change, its causes and consequences are more likely to adopt adaptation measures and mitigation practices to cope up with adverse effects of climate change.

Table 1: Distribution of respondents according to climate change awareness

	Abia State (n=172)
Yes (1)	134 (77.9)
No (0)	38 (22.1)

Figures in parenthesis ( ) are percentages. Source: Field survey data, 2016

These findings are also supported by Adebayo *et al. (*2012) who observed that large majority of the respondents in Adamawa state (about 96%) were aware of climate change, while only about 4 percent seemed not to be aware of climate change. Sogani, (2011) in a study of documentation of climate change perceptions and adaptation practices in Uttarakhand reported that communities in the mountain areas are well aware that the weather is changing. This also corroborated the findings of Ishaya and Abaje (2008), and Egbe *et al*., (2014) which shows a high level of climate change awareness among local farmers in Kaduna and Cross River area of Nigeria.

Table 2: Source of awareness about climate change

Source	Frequency	Percentage
Extension	88	51.16
Media (radio/television)	46	26.74
Friend/neighbours	26	15.12
NGOs and input sales agencies	12	06.98

Source; field survey, 2016

Table 2 shows the source of oil palm farmers' awareness about climate change. Majority (51.16%) got their information about climate change from extension agents,15.12% from friends and neighbours, and 26.74% through media (mainly radio), while a mere (06.98%) got the information from Non-Governmental Organizations (NGOs). This underscores the importance of interpersonal communication in creating awareness.

This section portrays oil palm farmers' perception of climate change in relation to their oil palm farm. Table 3 shows that 45% of respondents indicated that the effect of rainfall was less serious while 4% said it was very serious.

Table 3 Farmers' Perception of climate change variables.

Climate variables / seriousness of change	Frequency	Percentage	Mean
Rainfall			
Not serious	37	22	
Less serious	78	45	2.16
Serious	50	29	
Very serious	7	4	
TOTAL	**172**	**100**	
Humidity			
Not serious	34	20	
Less serious	37	21	
Serious	94	55	2.44
Very serious	8	4	
TOTAL	**172**	**100**	
Sunshine			
Not serious	15	9	
Less serious	24	14	2.75
Serious	122	71	
Very serious	11	6	
TOTAL	**172**	**100**	
Temperature			
Not serious	25	15	
Less serious	12	7	
Serious	54	31	3.11
Very serious	81	47	
TOTAL	**172**	**100**	

≥ 2.50 = serious, < 2.50 = not serious
Source: Field survey data, 2016.

As indicated in the Table 3, most of the farmers (47%) were of the opinion that Temperature is a serious issue. Farmers perception of climate change variables was achieved using mean score derived from 4 point likert scale with 2.50 decision rule. Farmers Reponses on observed climate variables and the level of seriousness in the area were as follows: temperature (χ = 3.11), Humidity (χ = 2.44), Sunshine (χ = 2.75), and rainfall (χ = 2.16). Findings from Table 3 show that significant number of farmers (51%) believe that rainfall has declined (less serious) .The above result is in agreement with BNRCC Report (2011) which concluded that farmers (both male and female), on perception of rainfall in Southern Nigeria, observed a decline in Rainfall. In their own contribution Agboola and Ojeleye (2007) observed decline in crop yield and food crop production due to reduction in rainfall and relative humidity and increase in temperature in Nigeria. Results show that farmers believe that temperature is serious. In their own contribution, Fonta *et al.,* (2011) observed that each crop has an optimum range of temperature and temperatures higher or lower than what can be tolerated by the oil palm could lead to reduction in yield and productivity. Temperature had the highest mean score followed by sunshine. Several studies have shown that temperature is rising and rainfall frequency and intensity is fluctuating (Mendelsohn *et al.*, 2000; Ozor and Cynthia, 2010); Paavola, 2006). It has been observed in Nigeria that sunshine duration shows an increasing trend (Nwajiuba and Onyeneke, 2010). The relationship between duration of sunshine and temperature is that the more the sunshine, the more the heat. More hours of daylight translates to more hours of heating from the sun. Adverse effects of heat stress itself occur in conditions where environmental temperature is elevated.

Conclusion

The high level of awareness about climate change among farmers in developing countries is an encouragement in effective implementation of their common undifferentiated commitments to the convention on climate change. High level of awareness will increase the adaptation potential of the community and make them less vulnerable towards climate change. The awareness of climate change has spread at an unprecedented pace and it is now accepted as a major threat to human survival and sustainable development. The increased adverse impact of climate change is expected on the environment, human health, food security, economic activities, natural resources and physical infrastructure. The study shows that farmers' perception of climate change, the decision making process is important to inform and /or in formulating policies aimed at promoting successful adaptation strategies for the Oil Palm industry. Part of the problem with climate change is the incidence of pest and diseases, particularly during dry spells. This is further exacerbated by the fact that farmers are often poorer and rarely have access to safe and effective pesticides, robust varieties of plants/seeds and adequate irrigation facilities. The government can do well by assisting the farmers with these necessary inputs at subsidized rate. It is important that government make issues of climate change awareness and perception top of its political agenda.

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SUB-THEME 8

ASN 52nd Annual Conference Proceedings

Analysis of Tractor Operators' Anthropometric Data from Malaysia and Nigeria

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Abstract

The agricultural tractor as marvelous as it is composed cannot be fully utilized without a compatible operator. Most tractors imported to developing countries such as Nigeria were designed without taking cognizance of the people to drive them. More so, no designer can provide necessary adjustments for all possible subjects. Thus, there is a need for continued documentation of tractor operators' anthropometric data. This study compares the anthropometric data of Nigerian and Malaysian tractor operators. This can be used by tractor fleet managers to adapt the operators with any tractor available or to be procured in the future.

Introduction

Agriculture is the mainstay of life, feeding the world's populations and producing shelter and clothing in order to survive and thrive (ISO, 2017 and Ahmed, 2000). Also, agriculture provides employment for the majority of Africa's people and generates a good share of GDP. Despite its important role, agriculture is largely underdeveloped in most African countries. There is high potential for expansion of the agricultural sector at all levels (Zhou, 2016). Over the past three decades, not only has progress delayed in agricultural mechanization in much of sub-Saharan Africa (SSA), but also there is amassing evidence that progress attained in the earlier years is being lost in many parts of the continent and achieving higher economic growth through the agricultural sector will not be easy without innovative solutions that change past strategies (Mrema et al., 2008). Africa is the only region in the world where agricultural productivity has been largely stagnant since 1960s. Average cereal production in Africa stood at 1.5 ton/ha in 2014; the world average was 3.6 ton/ha. The low levels of input use and mechanization have been cited as main constraints for agricultural development (Zhou, 2016). Mechanization of any agricultural task involves appropriate selection of energy source to power a suitable machine/equipment/implement in performing the task. Manual tools use human beings as both source of power and controller/operator (Suleiman and Imam, 1987). In animal draught technology (ADT) animals (donkeys, mules, cattle, horses and camels) provide the tractive power while humans serve as controllers/operators (Ahmed, 2000). In tractors or other automated machines powered by internal combustion engines (ICE), all power is provided by the ICE and the operators monitor the conduct of the task to be performed. There is a need to embrace tractor mechanization for medium to large scale farms in order to be self-sufficient in food production, earn foreign exchange and establish manufacturing industries to stop importation. Mechanization as an input for other inputs and largely not divisible/highly capital intensive has suffered from lack of maximum adoption in developing countries like Nigeria. Though Nigeria leads other countries in total number of tractors in West Africa (Figure 1), the situation changes when tractor usage per hectare is considered (Zhou, 2016). In year 2000, Côte d'Ivoire led the field with about three tractors per 1000 ha while Nigeria and most other countries in the region had less than one tractor per 1000 ha (Figure 2). China and India have nine and 13 tractors per 1000 ha respectively in the same year. The high number of tractors in Nigeria since 1970 was due to many programmes on tractorization aimed at harnessing the vast agricultural potentials in the country, including the establishment of tractor assembly plants in Kano and Bauchi. Tractor driving imposes a lot of physical and mental stress upon the operator. If the operator's seat is not comfortable, his work performance may be poor and there is also a possibility of accidents. The optimal design of tractor seat may be achieved by integrating anthropometric data with other technical features of the design. The seat dimensions recommended for tractor operator's comfort based on anthropometric data of 5434 Indian male agricultural workers were as follows: seat height of 380 mm, seat pan width of 420–450 mm, seat backrest width of 380–400 mm (bottom) and 270–290 mm (top) (Mehta et al., 2008). In order to enhance operational performance and reduce both fatigue and accident risk, it is fundamental to provide a safe and adequate working environment. Therefore, the working station must be adapted to the operator's anthropometric and mechanical characteristics (dos Santos et al., 2016). Yisa (2002) assessed the ergonomic suitability of two makes of Nigerian assembled tractors (Fiat and Steyr) designed and manufactured in Europe using 20 randomly selected subjects.

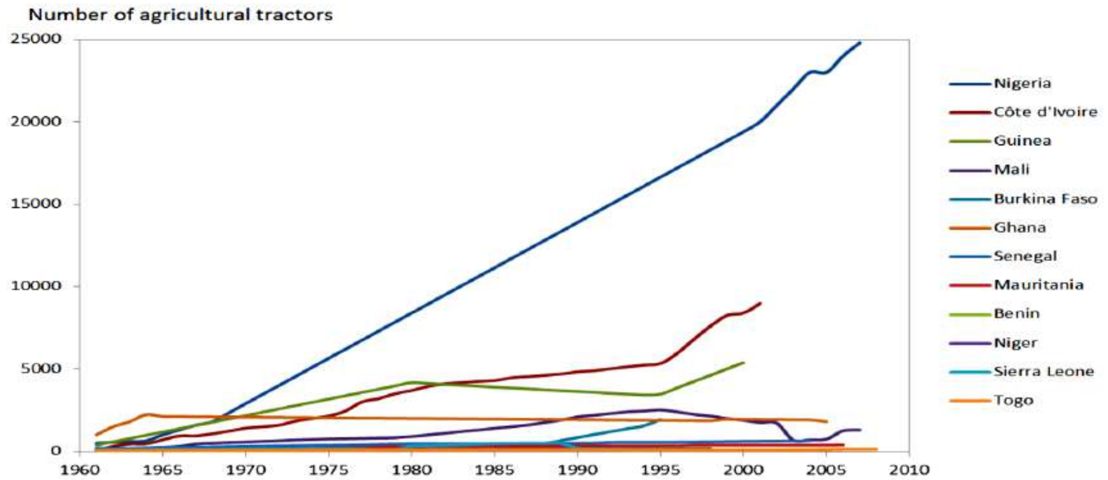

Figure 1: Number of agricultural tractors in use in West Africa, 1961-2008 (Data source: FAOSTAT)

These imported tractors need proper compatibility with operators for maximum utilization of the huge investment made. Thus, the objective of this study is to provide major anthropometric data of tractor operators from Nigeria and Malaysia for proper adaptation with ergonomic provisions of existing tractors and those planned to be procured.

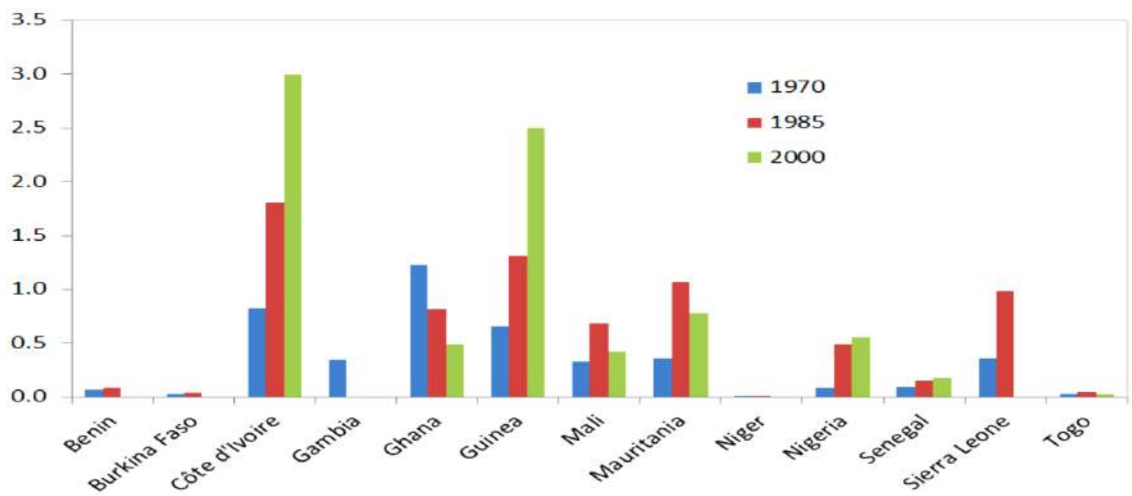

Figure 2: Agricultural tractors per 1000 ha (Data source: FAOSTAT)

Materials and Methods

Tractor operators from Refuse management and sanitation board (REMASAB) and ten local government areas in Kano State, Nigeria and Universiti Putra Malaysia (UPM) were used as subjects for the anthropometric measurements. All the subjects were treated to the same procedure as documented in Ahmad el. al., 2015. The tractor operator's anthropometric data collected were analysed to produce anthropometric model parameters of the study areas. The parameters were evaluated as was done by Yadav et al. (1999) in deriving the anthropometric model of Indian tractor operators. These include: mean, standard deviation, coefficient of variation, range and percentiles (5th, 95th and difference between the two).

Results and Discussion

The anthropometric data from Nigerian and Malaysian tractor operators are given in Table 1. The age of the Malaysian tractor operators (44 years) and that of Nigerians (45 years) are favourable. The average weight of Malaysian operators (72 kg) is higher than that of Nigerians (65.1 kg) although there is a high variation in Malaysian weights as indicated by higher standard deviation of 16.6. All other parameters show higher values of standard deviation for Nigerian data than those of Malaysia. This calls for Nigerian tractor managers to be more challenged in modifying tractor ergonomic designs for compatibility with available Nigerian operators.

Table 1: Comparison of anthropometric parameters between Nigerian and Malaysian tractor operators (Malaysian standard deviation in brackets)

Parameter	Nigerian average	Malaysian average	Range (Standard deviation)
Age (years)	45	44	(10.67)
Weight (kg)	65.1	72	7.7 (16.6)
Height (cm)	167.5	166.9	5.4 (6.7)
Full leg length (cm)	104.4	94.0	7.0 (5.0)
Full hand length (cm)	74.1	67.0	12.7 (3.8)
Knee length (cm)	52.2	49.3	3.4 (3.3)
Elbow length (cm)	47.2	44.1	2.8 (2.1)

Short operators will require lower steps for access on the tractor. Statistical analysis has revealed that 42 % of tractor accidents in a study were encountered during climbing in and out of the cab (Suutarinen, 1992). A study between 2005 and 2008, has reported 309 boarding accidents (Quendler et al., 2013). This number corresponded to 48% (309/644) of all moderate, severe and fatal tractor accidents in Bavaria, Germany. The direct costs of accidents were €11,310 (N4,524,000.00) on average! A nine-point compatibility criterion for operator anthropometry with tractor driver's seat design was proposed (Monarca et al. 2009). These points' criteria range from the seat base size to seat surface material-allowing for a suitable perspiration.

Conclusion

This study conducted a survey on tractor operators in Kano state of Nigeria and Universiti Putra Malaysia and determined their anthropometric models for adaptation with the available tractor ergonomic designs. The highest coefficient of variation (19%) among the six parameters measured Nigerian operators was in the full-hand length while the Malaysians recorded highest coefficient of variation in weight. This calls for better strategies of adapting different tractor hand controls and seat suspensions to the user population by the tractor fleet managers.

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SUB-THEME 9


FOOD SCIENCE, HOME
SCIENCE AND DIETETICS,
POSTHARVEST HANDLING,
PRODUCT DEVELOPMENT,
QUALITY STANDARDS FOR
LOCAL AND EXPORT
MARKETS

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Fortification of Cocoyam (*Colocasia esculentum*) Flour with Crayfish (*Cambarus batchi*) for Improved Nutritional and Health Benefits

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Abstract
This study was conducted to improve on the nutritional quality of cocoyam flour often used for various recipes with finely ground crayfish in the ratio of 75:25 (w/w). The proximate and mineral compositions of cocoyam flour (cooked, uncooked, and cooked/fortified with crayfish) were determined using standard analytical procedures. The results of the investigation showed that boiling greatly reduced the anti-nutrient compositions of the cocoyam. Calcium oxalate was reduced by 50%, tannin by 70% and phytate by 10% respectively. Cooked/fortified samples had remarkable increase in their caloric value, moisture, crude protein, crude fat, crude fibre and ash. Increase in the content of the mineral elements determined (calcium, phosphorus, potassium, magnesium and sodium) in the crayfish – fortified cooked cocoyam sample was observed with sodium having 101.99± 2-30 mg/100g and potassium 772.35± 5.78 mg/100g.

Key words: Cocoyam, crayfish, fortification, proximate and mineral composition

Introduction
Cocoyam (*Colocasia esculenta*) is an herbaceous perennial plant which is classified under the family Aracea and is mainly grown for their edible roots. Cultivars of two species, *Colocasia esculenta* and *Xanthosoma sagittifolium* tannia are generally grown for food. Cocoyam ranks third in importance after cassava and yam among the root and tuber crops that are cultivated and consumed all over the world especially in the developing countries such as Nigeria. Nigeria is the world's leading producer of cocoyam, accounting for about 40% of total production (Ajijola *et al.,* 2005). As a relatively known staple crop in the underdeveloped and developing countries, it can serve as a weaning food for children. Dietary energy is the main nutrient supplied by cocoyam as with other root and tuber crops. Cocoyam has a lot of health benefits which include cancer prevention, reduced symptoms of rheumatoid arthritis, immune system health, decreased muscle cramp, enhanced learning as well as act as a good recipe for diabetics (Nwankwo, 2015). In spite of its health benefits and importance as a staple food in many countries, cocoyam is still insufficiently studied and underutilized (Watanabe, 2002). Cocoyam however generally has a low protein content and often limited by its low content of sulphur- containing amino acids. By contrast, crayfish is of higher nutritional value, very rich in protein and essential amino acids and can complement the deficiencies of cocoyam. Crayfish also known as crawfish, fresh water lobsters or mudbugs are actually freshwater crustaceans. Taxonomically, they are members of the super families Astacoidea and/or Parastacoidea. They are nutritious and contain both major and minor mineral elements. Crayfish having lots of vitamins, mineral contents, amino acids and omega-3-fatty acids, when used in fortification of cocoyam will boost the consumers' nervous system and digestive system functions and overall body metabolism (Lewu *et al.,* 2010). It will also help in preventing the risk of anemia and other symptoms of malnutrition which are the major problems of the underdeveloped world. Research efforts need to be made and measures put in place to popularize, enhance and increase use of cocoyam as food among the populace through the adaptation of technologies used to increase the utilization of other root and tuber crops.

Materials and Methods

Source of Cocoyam: Cocoyam tubers used for this study were obtained from the cocoyam barn of NRCRI, Umudike in Abia State of Nigeria.

Production of Cocoyam flour: Cocoyam flour was prepared according to the method of Ukpabi and Oti, (2010) with slight modification. Fresh cocoyam roots were thoroughly washed, peeled and rewashed with clean water. Then the peeled tubers were sliced into small sizes, parboiled in hot water (50^{o}C for 3 hrs), steeped for 24 hrs and then dried at 50^{o}C for 8 hrs before milling into flour.

Production of finely ground Crayfish: Crayfish was purchased from a local market in Umuahia, Abia State of Nigeria. The crayfish was spread out in a tray and winnowed to remove all extraneous materials, washed with clean water and dried at 50^{o}C for 7 hrs before milling into crayfish powder.

Determination of Proximate Composition: The moisture, ash, crude fat and crude fibre contents of both the cocoyam and crayfish flour were determined according to the standard method (AOAC, 1990). Crude protein (N X 6.25) was determined by the Kjeldahl method as described by Okalebo *et al.* (2002). Carbohydrate content was obtained by difference. The caloric value of each sample was calculated using Atwater factor method (4 x carbohydrate) + (4 x crude protein) + (9 x crude fat).

Determination of Mineral Composition: The mineral content of the samples was determined using the method of Shahidi *et al.* (1999) with slight modifications. Total phosphorus was obtained using the ascorbic acid blue colour procedure of Okalebo *et al.* (2002).

Statistical Analysis

Statistical analysis system (SAS) software was used for analysis of data and the separation of means and their standard deviations.

Results and Discussion

The results of the proximate compositions of crayfish and cocoyam (cooked, uncooked and crayfish-fortified) are shown in Table 1. Parboiling has been found to decrease protein content of cocoyam due to leaching of nitrogenous substances during soaking and rupturing of molecules during steaming. Tannins have been reported to form complexes with protein, thereby limiting its availability (Otegbayo, 2014). The protein content of cocoyam is generally low (Okaka and Isieh, 2002), hence cocoyam products should be supplemented with other high-protein products for balanced nutrition. The cooked sample had higher crude fibre content than the uncooked. This observation could be due to the gelatinization and retro- gradation of the starch that occurred during the cooking process, which could change part of the starch into non-degradable polysaccharides (Olayinka *et al.,* 2017). This high fibre content of cocoyam may be why it is superior to the other root and tuber crops in protection against various ailments. The high moisture contents obtained for cocoyam in this study explains why post-harvest loss due to spoilage is always high for these tubers since high moisture content enhances microbial attack. The results also revealed an increase in the moisture content of the cooked sample. This could be attributed to the boiling effect that softens the tissue, thus increasing the water absorption and water-retention capacity of the tubers as a result of increased permeability of the cell membrane to water (Okaraonye and Ikewuchi, 2009). Cooking increased the fat content of the tubers (Table 1). This may be due to the increased extractability of the more polar lipids bound to other macro molecules in the tissue. The value however is still on the low for crude fat. Cooking reduced the ash content of cocoyam. This could be as a result of the solubilization and leaching of nutrients into the processing water. Both cooked and uncooked cocoyam samples are high in carbohydrates as common to all root and tuber crops. The results of the anti-nutrient analyses are presented in Table 2. Phytate, calcium oxalate and tannins are higher in the uncooked sample (86. 97, 669.78 and 4,198.78 mg/100g) as compared to their contents in the cooked sample (70.32, 330.75 and 1,859.67mg/100g) respectively. The results of this investigation showed that cooking greatly reduced the contents of the anti-nutrients in cocoyam. After cooking for 30 mins, the content of calcium oxalate was reduced by 50%, an indication that oxalate has a hydrothermal ability which could be attributed to the dual effect of thermal degradation and leaching. This reduction is necessary as oxalate has been found to decrease absorption of important elements as well as aid in the formation of kidney stones (Catherwood *et al.,* 2007). Phytates form complexes with the essential mineral elements and thus reduce their bioavailability and absorption. Cooking reduced the content of tannins to about 75%, which is a health benefit as tannins inhibit protein digestion and absorption. Table 3 shows the results of the mineral compositions of both crayfish and cocoyam (cooked, uncooked and crayfish-fortified). Cooking reduced the contents of all the essential mineral elements determined in this investigation with the exception of sodium. However, with the addition of crayfish to the cocoyam samples at the ratio 75:25 w/w, the results of the investigation showed remarkable increase in the nutritional and mineral contents in the cocoyam samples, thus making up for the losses due to boiling.

Conclusion

The results of this investigation showed that cooking reduced the anti-nutrient content of the cocoyam samples thereby improving its nutritive value and food quality. The cooked samples showed losses of some nutrients with respect to proximate and mineral compositions. However, fortification of cocoyam with crayfish is necessary to enhance the nutrient profile and ensure healthy diets for cocoyam consumers. Based on the results of this study nursing mothers especially in underdeveloped countries are advised to incorporate crayfish-fortified cocoyam meal in the diet of their children.

Table 1: Proximate composition (% dry matter)

	Moisture	Crude fibre	Crude protein	Crude fat	Ash	Carbohydrate	Caloric value (Cal/100g)
Cocoyam Uncooked	5.29±1.10	1.54±0.03	5.35±1.12	1.69±0.01	4.89±0.01	81.24±1.15	361.57±3.52
Cooked	8.53±1.15	2.74±0.06	4.07±0.27	1.10±0.01	3.58±0.05	79.98±1.05	346.1±2.68
Crayfish Cooked	48.70±1.15	3.85±0.35	15.89±0.01	1.10±0.01	6.20±0.82	24.44±1.13	171.22±2.15
Cocoyam + Crayfish	68.05±1.07	4.92±0.87	12.52±0.02	1.15±0.35	8.58±0.01	4.78±1.01	79.55±1.15

* Mean of five determinations ± standard deviation

Table 2: Anti-nutrient composition of cocoyam (mg/100g)

	Phytate	Calcium oxalate	Tannin
Cocoyam Uncooked	86.97±1.27	669.78±18.05	4,198.78±359.27
Cooked	70.32±0.98	330.75±14.23	1,859.67±299.02

* Mean of five determinations ± standard deviation

Table 3: Mineral content composition (mg/100g)

	Calcium	Magnesium	Phosphorus	Potassium	Sodium
Cocoyam Uncooked	32.84±0.28	113.78±2.32	37.58±1.02	907.19±5.87	65.35±0.85
Cooked	29.85±1.70	87.58±0.89	41.62±1.03	722.02±6.89	72.58±0.34
Crayfish	43.58±1.15	27.85±0.03	207.00±7.13	201.43±5.18	81.59±1.03
Cooked Cocoyam + Crayfish	40.73±1.15	94.44±1.03	93.32±1.07	772.35±5.78	101.99±2.30

* Mean of five determinations ± standard deviation

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Organoleptic Evaluation of *Tuwo* Prepared from Maize Grains Treated with Natural Products and Synthetic Insecticides against *Tribolium casteneum*

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Abstract
The study evaluated the organoleptic qualities of tuwo prepared from maize grains treated and stored with natural products (raw diatomaceous earth, kaolin powder) and synthetic insecticides (Rambo®, Pestox®) against Tribolium casteneum infestation under ambient laboratory conditions of 32.5±3 ℃ and 56.6±8% relative humidity. Each treatment was applied at the dose rate of 2, 4, 6 g/kg of maize grains. Two controls were also included in the set up: infested and un-infested control. Each was later infested with twenty adults Tribolium casteneum of mixed sexes and stored for 12 months. Each treatment was replicated three times in a Completely Randomized Designed. Sensory evaluation was conducted to assess the effect of these treatments on the organoleptic qualities of treated and stored maize, using a 9- point hedonic scale, ranging from dislike extremely to like extremely. One hundred grams of treated maize as well as the controls were measured, pounded into flour using pestle and mortar; tuwo was prepared from the flour, Questionnaires were administered to panelists to assess the effect of these treatments on colour, taste, aroma, appearance and overall appearance of tuwo and their responses were analyzed. The result show that sensory attributes of tuwo prepared from grains treated with lowest dose rate of raw diatomaceous earth was significantly preferred by the panelists. Also, tuwo prepared from un infested maize grain was significantly different from tuwo made from the infested maize grains in terms of colour, taste, aroma, appearance and overall acceptability.

Keywords: natural products, synthetic insecticides, Tribolium casteneum, tuwo and organoleptic evaluation

Introduction
Maize (*Zea mays* L.) is one of the most important cereal crop grown in Nigeria and constitute important sources of carbohydrates, proteins, vitamin B and minerals (Iken *et al,* 2002). In Nigeria, maize is the third most important cereal crop after sorghum and millet (Ojo, 2000). Maize cultivation started as a subsistence crop and has now risen to a commercial crop on which many Agro allied industries depend for its raw materials (Oladejo and Adetunji, 2012). Milled flour constitutes the major form in which maize are consumed in Nigeria (Umar *et al*., 2015). Insect pests cause damage to stored grain and processed products by reducing dry weight and nutritional value (Sinha and Watters, 1985). The attack of these crops begins in the field and continues in storage, which is liable to depredation with rapid increase in population of pest organism (Pretheep-Kumar *et al*., 2006). Losses of crops during storage, processing and marketing may be as high as 50%. The estimate of losses from time of harvest until consumption by man varies (Okunola *et al*., 2007). The red flour beetle, *Tribolium castaneum* (Herbst) is one of the most serious pest in milled products worldwide causing heavy loss (Mullen, 1992; Rees, 2004). The pest can cause damage to stored-products by feeding, and severely reducing the quality of crops due to product excrement and larval faeces. This pest makes serious damage on flour and crush cereal particularly at larval and adult stages. As well as, the pest causes damage on seeds containing high humidity (usually above 12%), makes conversion color of flour to gray and creates a bad smell on nutrient materials. Continuing presence of this pest caused to mold growth on grain and flour (Bennett, 2003; Baldwin and Fasulo, 2004). Synthetic pyrethroids are broad spectrum insecticides,

widely used because they are relatively safe for humans, their insecticidal potency is elevated at low dosages and they exhibit a rapid immobilization effect (WHO, 2005; Hénault-Ethier, 2015). Pyrethroids are neurotoxic poison and targets voltage-sensitive sodium channels. It also affects voltage-gated calcium channels, voltage-gated chloride channel and GABA receptors (Schleier and Peterson, 2011). Pyrethroids are used as grain protectants and against household pests, agricultural pests, fields and green house pests. They are also extensively used in animal houses and in the field of veterinary medicine (Hénault-Ethier, 2015). Several studies have demonstrated the efficacy of synthetic pyrethroids as grain protectants against storage insect pests including *T. casteneum* (Mansee and Montasser, 2003; Abdul Mujeeb and Shakoori, 2007: Andrić *et al*., 2015). Natural products, such as raw diatomaceous earth and Kaolin are inert dust, kill arthropods by removing the epicuticular lipid layers causing excessive water loss through the cuticle (Ebeling, 1971; Subramanyam and Roesli, 2000). These dusts have been widely used as grain protectants against stored product insect pests (Arthur, 2000; Arthur and Puterka, 2002; Timlick and Fields, 2010; Mahmoud *et al*., 2010; Kabir *et al*., 2013; Storm *et al*. 2016). However, very few studies have investigated the effect of these on the organoleptic properties of treated grains. Therefore, this study evaluated the organoleptic properties of *tuwo* prepared from maize grains treated with natural products (raw diatomaceous earth, kaolin powder) and synthetic insecticides (Rambo®, Pestox®) against infestation by *Tribolium castaneum*.

Materials and Methods

Study Site

The experiment was conducted in AGT laboratory, Department of Agricultural Technology, Ramat Polytechnic Maiduguri. Maiduguri is located at latitude 11°50′N and longitude 13°09′E. It lies on a vast open plain, which is flat with gentle undulations at an average elevation of 345m above sea level. The climate of the region is characterized by a cool-dry season (October to March), hot season (April to June) and a rainy season (July to September). The area is highly susceptible to drought with relative humidity of 13% and 65% in dry and rainy seasons respectively (Hess *et al*., 1996).

Sources of experimental materials

Maize (local variety) grains were purchased from Grain merchants at Maiduguri Monday Market. The grains were cleaned and disinfected at 60^{o}C for 3 hours in a hot air oven. Before the beginning of the experiments, the grains were equilibrated for 7 days under ambient laboratory conditions. The grains were broken down into smaller pieces using pestle and mortar. Pestox® and Rambo® both synthetic pyrethroids were purchased from Agro chemical Marketers at Maiduguri Monday Market. Raw diatomaceous earth was obtained from Department of Crop Protection University of Maiduguri Nigeria. Kaolin was obtained from Alkaleri Local Government Area, Bauchi State, Nigeria.

Rearing of *T. casteneum*

The adults of red flour beetle, *Tribolium castaneum* were obtained from laboratory cultures maintained at AGT laboratory, Department of Agricultural Technology, Ramat Polytechnic Maiduguri, Nigeria. The insects were reared on broken maize grains plus baker's (5% by weight). It entailed infestation of 500 g broken maize with 100 adults *T. castaneum* in a 1 – Litre glass jar to oviposit for one week; after which the parent were sieve out. The jars were covered with perforated lids to permit ventilation and prevent escape of adult insect. The adults which subsequently emerged was used for experiment. All cultures were maintained left under ambient laboratory conditions of 32.5±3°C and 56.6±8% relative humidity.

Bioassay procedure

One hundred grams of broken maize was weighed into 500 ml glass jars using Metler® electronic balance and admixed with 2, 4 and 6 g of raw diatomaceous earth, kaolin powder, Rambo® and Pestox®. Un-infested control and infested control were also set up. After treatment, all the jars, except the controls were vigorously shaken to ensure effective admixture and the content were allowed to settle for an hour. Thereafter, each jar was infested with twenty newly emerged *T. castenum* adult of mixed sexes. The jars were covered with a mesh to facilitate ventilation and prevent escape of the insect. Each treatment was replicated three times; labelled and arranged in a completely randomized design (CRD) under ambient laboratory conditions at 32.5±3°C and 56.6±8% relative humidity. The set up was left under these conditions for 12 months.

Tuwo preparation and Sensory evaluation

After, 12 months of storage, one hundred grams of broken maize per replicates were picked, cleaned and ground into flour using pestle and mortar. The flour was package in a polythene bag

and mixed with water, it was cooked in a pot over a kerosene stove for 1 hour and 27 minutes. No additive or salt was added.
Sensory evaluation of the *tuwo* was carried out by twenty untrained panelists, which were students in the Department of Agricultural Technology, Ramat polytechnic, Maiduguri. *Tuwo* were served to the panelists with questionnaires administered to assess the effect of the treatments on the sensory parameters of colour, taste, aroma appearance and overall acceptability of *tuwo* using a 9-point hedonic scale ranging from 1- dislike extremely to 9- like extremely. The panelists were instructed to rinse their mouth with sachet water after each test.
Statistical Analysis
The sensory evaluation data obtained from the questionnaires were subjected to one-way analysis of variance (ANOVA) using the statistical software Statistix 8.0 (Statistix, 2007). Means were compared using the Tukey-Kramer (HSD) test ($p < 0.05$).

Results and Discussion

The results of the organoleptic ratings by 20 panelists of *tuwo* prepared from broken maize grains treated with natural products and synthetic insecticides and stored for 12 months are presented in Table 1. Sensory evaluation of *tuwo* prepared from the infested maize grains showed significant differences (p<0.05) in colour, taste, aroma, appearance and overall acceptability from *tuwo* prepared from un infested maize grains. Also, the different treatment had no significant effect on colour, taste, aroma, appearance and overall acceptability of *tuwo* prepared from *treated maize grains.* However, the highest score for the colour (7.6) was recorded at 2ml of raw diatomaceous earth then followed by 2ml of kaolin powders and least score was obtained at 6 ml of Rambo, which was significantly different ($p < 0.05$) from infested control. Similar trends were observed for some of the sensory attributes like taste, aroma, appearance and overall acceptability (Table 1).

The application of raw diatomaceous earth, kaolin powder, Rambo® and Pestox irrespective of the dose rates used did not significantly alter the colour, taste, aroma, appearance and overall appearance of *tuwo* prepared from the treated grains. This could be an indication that the constituents of these treatments were not absorbed by the processed grains. This confirms with Mundi *et al*. (2012) which reported that taste and flavour of 'Okpa' prepared from flour of bambara groundnut seeds treated with *Anogeissus leiocarpus* (Guill and Per.), *Antidesma venosum* (Tull.), *Maranthes polyandra* (Benth.) Prance. *Mitragyna inermis* (Willd.) Kuntze and *Vitex madiensis* (Olive) were not adversely affected by the leaf powdered treatments and rated fair in overall assessment. Ojiako and Kayode (2014) observed that pirimiphos methyl and powdered plant materials had no significant effect on the quality parameters of cooked cowpea seeds. It was observed in this study, that the colour, taste, aroma, appearance and overall appearance of *tuwo* prepared from the treated grains was accepted and preferred by the panelists, compared to *tuwo* made from the infested flour. Also, the panel of judges rated the *tuwo* made from infested flour lower than the *tuwo* prepared from un-infested flour in all the sensory attributes evaluated. This demonstrated that insect infestation has severely depleted the quality of infested flour, which as well affected the *tuwo* made from the infested flour. The findings of this study agrees with Babarinde *et al*. (2010) which reported that infestation of plantain chips by *T. castaneum* caused some physical and biophysical deterioration of the chips. Also, Babarinde *et al.*, (2013) reported that infestation of yam chips by *Dinoderus porcellus* affected the quality and acceptability of "*Amala*'.

Conclusion

In conclusion, the natural products (raw diatomaceous earth, kaolin powder) and synthetic insecticides (Rambo®, Pestox®) used did not adversely affect organoleptic properties of maize grains stored for six months. Seeds stored with some of these products also had satisfactory organoleptic characteristics.

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Table 1: Mean sensory scores of *tuwo* prepared from maize grains treated with natural products and synthetic insecticides against infestation by *Tribolium casteneum*

Treatments	Dose rate (g/kg)	Colour	Taste	Aroma	Appearance	Overall acceptability
	4.0	6.1±0.5^{ab}	5.9±0.7^{a}	5.8±0.7^{ab}	5.9±0.7^{ab}	6.6±0.6^{a}
	6.0	7.1±0.6^{a}	6.0±0.6^{a}	7.0±0.4^{ab}	5.8±0.6^{ab}	7.1±0.6^{a}
Pestox®	2.0	6.1±0.6^{ab}	6.2±0.7^{a}	6.7±0.6^{ab}	6.7±0.5^{a}	7.2±0.5^{a}
	4.0	5.6±0.5^{ab}	5.9±0.7^{a}	5.6±0.5^{ab}	6.9±0.6^{a}	6.3±0.6a
	6.0	5.7±0.7^{ab}	6.3±0.7^{a}	5.8±0.6^{ab}	6.1±0.6^{ab}	7.0±0.5^{a}
Rambo®	2.0	5.7±0.6^{ab}	6.4±0.5^{a}	6.2±0.5^{ab}	6.0±0.7^{ab}	6.5±0.7^{a}
	4.0	6.3±0.7^{ab}	6.4±0.6^{a}	7.5±0.5^{ab}	6.8±0.7^{a}	6.4±0.6^{a}
	6.0	6.5±0.6^{a}	6.6±0.6^{a}	6.8±0.6^{ab}	7.1±0.6^{a}	7.2±0.4^{a}
Kaolin powder	2.0	6.3±0.6^{ab}	6.6±0.6^{a}	6.2±0.6^{ab}	6.0±0.7^{ab}	6.1±0.8^{a}
	4.0	6.4±0.5^{a}	7.1±0.5^{a}	6.6±0.5^{ab}	6.3±0.6^{ab}	6.2±0.8^{a}
	6.0	5.5±0.5^{ab}	7.0±0.5^{a}	5.6±0.6^{ab}	7.2±0.6^{a}	6.6±0.6^{a}
Infested control	0.0	3.7±2.9^{c}	2.9±0.3^{b}	3.6±0.4^{c}	3.6±0.4^{c}	3.3±0.4^{b}
Un-infested control	0.0	8.1±0.2^{a}	8.3±0.2^{a}	8.3±0.2^{a}	8.2±0.2^{a}	8.7±0.1^{a}

Mean with the same superscripts in a column are not significantly different from each other ($p < 0.05$) at Tukey-Kramer's HSD

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Roles of Food Science and Technology in the Agro-Food Sector in Nigeria: A Review

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Abstract
The paper assessed the roles of food science and technology (FST) in the agro-food sector in Nigeria. Specifically, it explained the concept of food science, nanotechnology in food sector, the roles of FST and challenges of FST. Food Science is a multi-disciplinary field involving chemistry, biochemistry, nutrition, microbiology and engineering to give one the scientific knowledge to solve real problems associated with the many facets of the food system. Nanotechnology has the potential to improve food processes that use enzymes to confer nutrition and health benefits but there is an urgent need for regulation of nano-materials before their incorporation into food processing, packaging, and food contact. The concept of food science indicates that there are basic sciences and engineering to study the physical, chemical, and biochemical nature of foods and the principles of food processing. Previous empirical findings revealed that nano-materials can be used to provide superior enzyme-support systems due to their large surface-to-volume ratios compared to traditional macro-scale support materials in order to make enzymes highly active, long-lived and cost-effective. It was further revealed that FST improves the feeding of a nation and helps in productivity. One of the major challenges of FST is lack of basic social amenities. The review concluded that more focus should be diverted to make more research on the benefit impact of adequate provision of social amenities on FST. It was recommended that more research studies are required to investigate the hazards of nanotechnology in foods and the government should make available basic social amenities and promote research on food science and technology.
Keywords: Food science, Health, Nanotechnology, Food preservation and Food processing

Introduction
The Agro food industry is a vital integral of economic growth of any country. Various cash crops that are produced in different countries could be major sources of economy if properly managed. A strong and efficient agricultural sector would enable a country to feed its growing population, generate employment, earn foreign exchange and provide raw materials for industries. The agricultural sector has a multiplier effect on any nation's socio-economic and industrial fabric because of the multifunctional nature of agriculture (Ogen, 2007). Agriculture could be said to be the mainstay of many economies and it is fundamental to the socio-economic development of a nation because it is a major element and factor in national development. The Agro-foods industry plays a fundamental role in the creation of income and employment opportunities in developing countries. The agro-processing sector is by far the most significant component in the agro-food industry and covers a broad area of postharvest activities, packaged agricultural raw materials, industrial and technology intensive processing of intermediate goods and the fabrication of final products derived from agriculture (UNDP, 2012). Okolo, (2004) described the agricultural sector as the most important sector of the Nigeria economy which holds a lot of potentials for the future economic development of the nation as it had done in the past. Agriculture contributes over 40% of Nigeria's GDP, employs over 70% of the population, and produces about 80% of the food needs Aye, (2013). Although, agriculture still accounts for about 88% of non-oil export earnings, its contribution has seriously declined over the decade falling from about 75% of total export earnings in the 1960s to less than 3% currently Oji-Okoro,(2011). Food security has been defined in terms

of food availability and its accessibility to people (Olaoye et al, 2013). It is believed that there can be no food security without its availability; its safety must however be guaranteed. Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 2001). The discovery and utilization of scientific principles in food technology have provided a supply of safe, wholesome, and nutritious foods unknown before in history (Clydesdale, 1989). As a result, life spans in the industrialize world have increased. The most significant contribution and achievement of Food Science and Technology (FST) worldwide to development is possibly the supermarket. For those people not familiar with them, it is simply fascinating to walk aisle after aisle admiring the variety of attractive cartons, cans, and many other fancy containers with all kinds of foods. On the other hands, it is also fascinating to walk through the narrow passages of the colourful open markets typical of developing countries. There, the variety of foods is low, mainly cereal grains and food legumes in burlap bags. Occasionally, baskets full of foods, mainly vegetables and fruits, are also to be found, but their availability is dependent on seasonal production (Bressani, 1989). The most crucial contribution of FST to national development given a proper technological framework is seen in their effectiveness in increasing food production and productivity of some agricultural crops, decreasing food losses, increasing food availability, reducing seasonality, providing employment and higher income, making available high nutritive value foods and in general increasing the economic situation. The objective of this review is to explain the roles of FST in the agro-food sector in Nigeria. Specifically, it explained the concept of food science, the concept of nanotechnology in food sector, the roles of FST in agro foods production, preservation, processing and the challenges of FST.

Food science

Food Science is a multi-disciplinary field involving chemistry, biochemistry, nutrition, microbiology and engineering to give one the scientific knowledge to solve real problems associated with the many facets of the food system (Baianu, 2012) The basis of the discipline lies in an understanding of the chemistry of food components, such as proteins, carbohydrates, fats and water and the reactions they undergo during processing and storage. A complete understanding of processing and preservation methods is required including drying, freezing, pasteurization, canning, irradiation, extrusion, to name just a few. The ability to carry out analysis of food constituents is developed along with statistical quality control methods. The microbiology and the safety aspects of food must also be understood. Other topics it covered include food additives, the physio-chemical properties of food, flavor chemistry, product development, food engineering and packaging. Food science integrates this broad-based knowledge and focuses it on food (Sadat et al, 2017)

Nano-technology in Food Sector

Food is nanofood when nanoparticles, nanotechnology techniques or tools are used during cultivation, production, processing, or packaging of the food (Ravichandran, 2010). Nanotechnology also has the potential to improve food processes that use enzymes to confer nutrition and health benefits. For example, enzymes are often added to food to hydrolyze anti-nutritive components and hence increase the bio-availability of essential nutrients such as minerals and vitamins. To make these enzymes highly active, long lived and cost-effective, nano-materials can be used to provide superior enzyme-support systems due to their large surfaces to volume ratios compared to traditional macro-scale support materials (Ansari, 2012). Nanotechnology has the potential to revolutionize the global food system. Novel agricultural and food safety systems, disease-treatment delivery methods, tools for molecular and cellular biology, sensors for pathogen detection, pesticides, packaging materials, environmental protection and education of the public and future workforce are examples of the important impact that nanotechnology could have on the science and engineering of agriculture and food systems (Moraru *et al*., 2003; Bouwmeester *et al.,* 2009). According to Alfadul *et al,* (2010), the food market demands technologies, which are essential to keep market leadership in the food processing industry to produce fresh authentic, convenient and flavourful food products. Prolonging the product shelf life and freshness as well as improving the quality of food are the target. Nanotechnology is a technology that has the potential to revolutionize the food industry. Detection of very small amounts of chemical contaminants, virus or bacteria in food systems is another potential use of nanotechnology (Shefer *et al,* 2003**)**. Consequently, it could be noticed that nanotechnology is a scientific area of rapid growth worldwide; many consider it as the basis for the next industrial revolution. It is possible that in the near future no country would be able to escape from the necessity of reseansariod packaging within the next decade, (Reynolds, 2007). The significant purpose of nano-packaging is to set longer shelf life by improving the barrier function of food packaging to reduce gas and moisture exchange and UV light exposure, (Sorrentino *et al,* 2007). There is an urgent need for regulation of nano-materials before their incorporation into food processing, packaging, and food contact. Nano-materials must not cause any health risks for consumers or to the environment (Alfadul *et al*, 2010).

Roles of Food Science and Technology

FST has overtime played crucial roles in Agro foods production, preservation and processing. Samuel, (2017) recently revealed that an estimated 25 per cent of all food produced in some developing countries is never consumed by humans. Instead, it spoils or is eaten by insects, rats and other pests. FST helps enhance reduction in food wastage by the following measures; control of rats by trapping, poison, rat-proofing grain stores, control of insects by use of insecticides, better food stores and airtight food containers, control of fungi and food rot by storage of food in as dry a state as possible and by use of better containers, control of birds by destruction, especially in millet and wheat areas and protective measures against monkeys, baboons, porcupines, wild pigs and other destructive animals, even elephants.

Challenges Faced With Food Science and Technology

Food is the substances taken that nourishes the body and gives the body strength to function effectively. Food makes one healthy to carry out necessary duties, food has many sources the main and traditional sources of food are agriculture and water bodies. Important food crops of Nigeria are cereals, grains, legumes, pulses, oilseeds, fruits, vegetables, spices and herbs, tea, coffee, sugarcane, honey, milk, meat, poultry and egg (Ogunfowoke, 2012). Since FST plays a vital role in Nigeria, it helps in food production, processing and preservation. Food is necessary for survival. A nation or country should be able to provide food for its people either in season or out of season. FST is expected to improve the feeding of a nation and helps in productivity. Factors affecting food insecurity in Nigeria are inadequate investment in agriculture, lack of financial support for farmers (especially the rural farmers), expensive agrochemicals, poor storage facilities, poor enforcement of agricultural policies (Philips *et al.,* 2008).

The challenges faced with FST are not limited to the following:

1. Lack of scientific and technical knowhow: Most of our institutions in Nigeria lack equipment to carry out practical works in relation to food science and technology. The student are been taught theoretical aspect of the work only instead of taking the student through technical/ practical and theoretical aspect.
2. Post- harvest food losses: after harvesting of the farm produces, some of the products are been infested by insects and rodents. Some spoilage also occur due to mould and invasion by bacteria thereby reducing the quality and quantity of the farm produces.
3. Lack of adequate machines and equipment for storage and processing: some farmers especially those in the rural area still make use of local/manual farm tools such as hoes and cutlasses and methods. Mechanized farm tools are not readily available, only few mechanized farm tools and equipment are available.
4. Lack of social amenities: social amenities such as access to good road, electricity supply, water are necessary. Lack and bad access to all these basic social amenities affects the effectiveness of food science and technology

Conclusion

The review concluded that more focus should be diverted to make more research on the benefit impact of adequate provision of social amenities on food science and technology. Food science and technology institutions should be encouraged to carry out collaborative research and partnerships from different sources including the private sector, non-governmental organizations so as to guarantee food security and increase the Nation's food exportation rate. More research studies should be done to investigate the hazards of nanotechnology in foods and the government should make available basic social amenities and promote research on food science and technology

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Effect of Different Methods of Extraction on Quality and Yield of Castor Oil

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Abstract
Castor oil is a vegetable oil obtained by pressing the seeds of the castor oil plant (Ricinus communis). This study was to determine the best method for local expression of the oil without affecting the physiochemical properties. Three methods (Soxhlet, cold press and hot press) were employed for the oil expression and the physiochemical properties were measured using AOAC methods. The results revealed that Soxhlet which is laboratory method give best yield (51.87±0.18 %) compared to that of cold press (35.63± 0.70%) and hot press (13.62± 0.68%). The physiochemical properties of the oil were within recommended standard but hot press was significantly different from other methods. From the result of this study, castor oil extraction should be carried using cold press for optimum yield of the oil.
Keywords: cold press, hot press, Castor oil and oil expression

Introduction
Castor is a member of the Euphorbiaceae family that is found across all the tropical and semi tropical regions of the world (Weiss, 2000). Castor bean (*Ricinus comminus* L.) is cultivated for its seeds which yield viscous, pale and non-volatile yellow oil (Tchuenteu *et al*., 2013). The oil is nonedible and has been used almost entirely for pharmaceutical and industrial purposes. Notably it is used in the manufacture of paints, dyes, inks, waxes, varnishes, lubricants and brake fluids e.t.c (Ogunniyi, 2006). The castor oil obtained by cold pressing of seeds is also used in household for soap production and as purgatives and laxatives (Weiss, 2000). Castor oil is a vegetable oil obtained by pressing the seeds of the castor oil plant (*Ricinus communis*) (Thomas, 2005).). Castor oil is a colorless to very pale yellow liquid with a distinct taste and odor once first ingested. Its boiling point is 313 °C (595 °F) and its density is 961 kg/m3. It is a triglyceride in which approximately 90 percent of fatty acid chains are ricinoleates. Oleate and linoleates are the other significant components(Mutlu and Meier, 2010). Castor oil is unique among vegetable oils because it is the only commercial source of a hydroxylatedfatty acid (ricinoleic acid). Castor seed contains 50% oil. But due to difficulty in extraction, some parts of its oil are impossible to be extracted. Unlike high saturated degree, castor oil is one of the stable oil The oil contains around 90% of the fatty acid (Ogunniyi, 2006).

Methodology
The castor seeds were obtained from Castor Research Programme of the National Cereal Research Institute (NCRI), Badeghi, Niger State, Nigeria.

Oil Extraction

For soxhelt extraction, 2g of the milled sample was placed in a paper thimble and fed into a Soxhlet extractor which was fitted with a 500 mL round bottom flask and a condenser. The oil was extracted by using n-hexane (as an extracting solvent) on water bath for 6 h. After extraction, the extra hexane was distilled off under vacuum in a rotary evaporator at 45°C (Federation of Oils Seeds and Fats Association (FOSFA), 1982). The extracted oil was weighed and the yield was calculated. In cold pressing, oil was extracted by locally made hydraulic press without using any chemicals for 30 min. Also, hot pressing oil was extracted by locally made mechanical oil extractor.

Oil Physiochemical Analysis

Physical Properties: Percentage oil yield was determined using weight by weight method. Refractometer was used to determine the refractive index of oil at room temperature and the specific gravity was determined using density bottle (weight by weight method)

Chemical Properties: The determination of chemical properties such as acid value, iodine value and saponification value was carried out using Association of Official Analytical Chemist (AOAC) Method of 2006.

Results and Discussion

The effect of extraction methods on the oil yield of the castor seeds is as shown in Table 1. There was a significant diferent ($p > 0.05$) in % oil yield from castor seed extracted using Soxhlet, cold press and hot press methods. The oil yield obtained from Soxhlet method was highest (51.87±0.18 %) compared to that of cold press (35.63± 0.70%) and hot press (13.62± 0.68%). Different methods of oil extraction gives different yields of oil (Alirezalu *et al.,* 2011). In the present study, the highest values of oil yields (51.87±0.18%) obtained using Soxhlet extraction method was in agreement with the findings of Nadeem *et al.* (2015) who evaluated the effect of cold press and Soxhlet extraction on the physico-chemical properties of sunflower seed oil. Castor oil extraction using solvent extraction has been reported to be about 46-55 % yield (Oguniyi, 2006). Muzenda (2012) in his study on the optimization of different parameters for castor oil production reported an oil yield of 50.16 % using Soxhlet method. Yusuf *et al.* (2015) in their extraction and characterization of castor seed oil from wild *Ricinus communis* linn reported a yield (39.43 %). Similarly, Akpan *et al*. (2006) achieved an average recovery of 33.2% of castor oil through Soxhlet extraction protocol.The sharp decrease in oil yield of hot press was as a result of sludge formation which may be caused by activation of castor seed enzyme (Muzenda, 2012). All other physiochemical properties of the oil measured were within the recommended standard by American Society for Testing and Materials International (ASTM) and that of the British Pharmacoepia Standard (BPS) for industrial use of castor oil and medicinal use of castor oil respectively, but there is no significant different between Soxhlet and cold press methods but there was significant different between hot press and other two methods.

Conclusion

The study has revealed that castor oil extraction should be carried out with cold press method for improved oil yield and quality.

Table 1: Physiochemical properties of castor oil from various extraction methods

S/n	Physical properties	Soxhlet extraction	Cold press	Hot press
1	Oil yield (%)	51.87 ± 0.18^{a}	35.63± 0.70^{b}	13.62± 0.68^{c}
2	Specific gravity	0.9492±0.050^{a}	0.9592±0.012^{a}	0.9580±0.019^{a}
3	Refractive Index	1.4728±0.023^{a}	1.4781±0.062^{a}	1.4674±0.089^{a}
4	Colour	Amber	Amber	Dark ash(greyish)
Chemical Properties				
1	Acid value (mg/g)	1.148±0.23^{a}	1.152±0.11^{a}	1.094±0.08^{a}
2	Iodine value (mg/g)	87.72±0.39^{a}	88.24±0.48^{a}	84.27±0.87^{b}
3	Saponification value (mg/g)	185.85±1.24^{b}	188.58±2.16^{a}	179.68±0.98^{c}

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Food Content Development in Shea Fruits Mesocarp (Pulp) at Different Stages oGrowth

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Abstract
The shea tree which has remained neglected with limited nutritional information of the shea fruit has exceptional short, medium and long term prospects for development. The food content including Moisture, Lipid, Protein, Ash, Fibre and Nitrogen free extract content of the shea fruit mesocarp has been studied at different stages of growth using standard methods. The proximate content was determined by harvesting the fruits at weeks 4, 8, 10, 12, 14, 16, 18 and 20 after flowering and the results of the fruit content were recorded. The percentage moisture contents, lipid contents, ash contents, protein contents and nitrogen free extract content ranged from 57.50±0.06% to 67.00±0.20%, 4.30±0.05% to 22.10±0.03%, 2.50±0.32% to 6.00±0.10%, 2.27±0.02% to 9.25±0.03%, 7.70±0.10% to 15.00±0.30% and 56.75±0.29% to 77.53±0.11% respectively. The result of this study has highlighted periods of high and low food contents in a shea fruit mesocarp post flowering which could suggest the best periods of their harvest depending on the purpose for cultivation.

Introduction
The shea tree, *Vitellaria paradoxa* is typically a Savanna woodland tree species (Eneh, 2010). The shea tree is an indigenous wild tree plant of African savanna parkland (Hall *et al*. 1996) and has been included in the priority list of African Genetic Resources by the FAO (1997). The fruit consists of a green fleshy mesocarp, which is sweet when eaten ripe and locally consumed like mangoes (Eneh, 2010) or other wild seasonal fruits. Typically, the fruit consists of mesocarp with nut which houses the kernel. The kernel oil (or fat) is the shea butter. The shea tree can live for more than 200 years (Eneh, 2010). The development of the fruit from flower starts from the stage of fertilization (Fruit Development Stages, 2016). The main growth of the fruits from the seeds include three main parts which includes; Fertilization, Embryology and Fruits and Seeds maturation (Fruit Development Stages, 2016). Mbaiguinam *et al.*, (2007) stated that earlier studies elsewhere have reported the existence of important nutrients in the shea fruit pulp, normally consumed by the local population to supplement diet from staple foods. The nutritional and economic importance of shea butter has been emphasized over that of the shea fruit. The fleshy shea fruit mesocarp is sometimes fermented, given to animal or left to rot and is discarded in favour of the shea nuts for shea butter production (Enabuere *et al*., 2014). Therefore, there is need to exploit the shea fruit mesocarp (pulp) for further use in the food and drug industries. The aim of this study is to determine and compare the proximate composition of shea fruits mesocarp (pulp) at different stages of development. The nitrogen free extract (an inaccurate name because this fraction has nothing to do with nitrogen and it is not an extract either) referred to in this study is the soluble part of carbohydrate while the crude fibre represents the insoluble portion of the carbohydrates.

Materials and Methods
Shea trees were selected and marked for this experiment and shea fruits were harvested from the marked trees in the Nigerian Institute for Oil Palm Research (NIFOR) sub-station, Bida, Niger State at different weeks (4, 8, 10, 12, 14, 16, 18 and 20 weeks respectively) after flowering and analysed

for the food content (Moisture, Oil, Protein, Ash, Fibre and Nitrogen free extract) upon which data documentation and analysis were done. Before analysis, the shea fruits were peeled (to remove the mesocarp). The mesocarp was used for the analysis. The mesocarp was dried, powdered and analysed. All reagent used in the analysis were of analytical grade and standard. Percentage moisture was determined by AOCS (1997) method. Lipid content was obtained by weight difference after extracting the oil with 96% pure n-hexane (Scharau, Spain) in a soxhlet apparatus for 18 hours. AOAC (2010) method was used to measure the ash and nitrogen contents. The ash content was determined by weight difference between the sample and the ash after incinerating the samples in the muffle furnace at 550^0C. The protein content was determined by Kjeldahl method and converted to percentage protein by multiplying with the Atwater factor. Nitrogen free extract (NFE) was calculated by difference using the equation:
%NFE = 100 – (%lipid + %ash + %crude protein + %fibre)
All chemical analyses were done in triplicate. The data generated were analysed using the SPSS software version 17. The means and standard deviation were then computed to further carryout the analysis of variance (ANOVA) at $P < 0.05$ to determine difference between means.

Results and Discussion

The results for the chemical analysis of shea fruit mesocarp are presented in Table 1. The observed moisture content and NFE of the mesocarp was statistically similar all through the study period $P > 0.05$. It was also observed that the lipid content of the mesocarp increased from the fourth week (6.80%) to its highest at the eighth week (22.10%) and the decreased almost gradually until the twentieth (last) week (4.30%) $P < 0.05$. It was observed that the ash content of the mesocarp increased almost steadily from the fourth week (2.50%) to the sixteenth and twentieth week where it had its highest percentage contents (6.00% and 5.20% respectively) with a little dip in the eighteenth week. Protein content of the mesocarp was observed to be highest at the fourth, sixteenth and eighteenth week of this study (9.25%, 8.26% and 6.58% respectively) and the lowest at the eighth, tenth, twelfth and fourteenth week (2.65%, 2.40%, 2.32% and 2.27% respectively). Whereas lowest fibre contents (7.70%, ,8.80% and 8.70%) were recorded at the beginning and last weeks of this study (fourth, eighteenth and twentieth week respectively) highest fibre contents ranging from 12.20% to 15.00% were recorded in between. The matured fruits in this study at week twenty had 57.5% moisture, 4.3% lipid, 5.2% ash, 6.6% protein, 8.7% fibre and 75.2% carbohydrate in the mesocarp, which is in agreement with Onwuka (2005), that shea fruit pulp is a rich source of energy and capable of supplying the daily energy requirements of the bodies of humans and livestock. This should also support promoting consumption of shea fruit as being of great benefit to the human diet as envisaged by Enabuere et al. (2014).

Table 1: Proximate nutrient composition of the analysed shea fruits mesocarp

Weeks	Moisture (%)	Lipid (%)	Ash (%)	Protein (%)	Fibre (%)	NFE (%)
4	67.00 ± 0.20	6.80 ± 0.03	2.50 ± 0.32	9.25 ± 0.03	7.70 ± 0.10	73.75 ± 0.11
8	57.70 ± 0.60	22.10 ± 0.03	3.50 ± 0.10	2.65 ± 0.05	15.00 ± 0.30	56.75 ± 0.29
10	57.60 ± 0.65	14.60 ± 0.03	3.70 ± 0.10	2.40 ± 0.03	14.30 ± 0.06	65.00 ± 0.06
12	57.60 ± 0.06	9.40 ± 0.05	3.80 ± 0.15	2.32 ± 0.03	14.90 ± 0.15	69.58 ± 0.09
14	57.90 ± 0.10	8.30 ± 0.12	4.70 ± 0.06	2.27 ± 0.02	13.80 ± 0.10	70.93 ± 0.10
16	58.70 ± 0.06	7.70 ± 0.06	6.00 ± 0.10	8.26 ± 0.02	12.20 ± 0.15	65.84 ± 0.15
18	66.40 ± 0.00	5.50 ± 0.12	3.90 ± 0.15	4.27 ± 0.04	8.80 ± 0.10	77.53 ± 0.11
20	57.50 ± 0.06	4.30 ± 0.05	5.20 ± 0.06	6.58 ± 0.02	8.70 ± 0.10	75.22 ± 0.15

Note: Mean ±SD (n=3)

Conclusion

The result of this study has highlighted periods of high and low food contents in a shea fruit mesocarp post flowering which could suggest the best periods of their harvest depending on the purpose for cultivation.

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Post-Harvest Losses and Storage Practices of Root and Tuber Crops' Farmers in Abia State, Nigeria

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Abstract
The major setback to attaining food security in Nigeria is substantial post-harvest losses. This study was conducted to assess the post-harvest losses and storage practices of root and tuber crops' farmers in Abia state, Nigeria. A multi-stage random sampling procedure was used to select 120 farmers from the State. Data were collected with the use of structured questionnaire and analyzed with means, percentages as well as Likert type scale. Results indicated that majority of the respondents (73.3%) were not aware of improved methods of storing root and tuber crops. Respondents' perceived that post-harvest losses due to rodents/insects (1.98); change in colour and flavour (1.88); inadequate transportation system (1.85); and traditional processing system (1.64) were moderate while losses due to mould and rot (2.05); lack/inadequate storage facilities (2.27); and inadequate drying equipment (2.14) were high. Farmers' perception on the effectiveness of the traditional storage methods of root and tuber crops revealed that none of the methods was effective while some of the constraints to adoption of adequate storage practices in the study area include lack of capital (4.33), lack of awareness on improved storage methods (2.84) and high transportation cost (4.13). The study thus recommended among other things increased dissemination of improved storage practices by ADPs and encouragement of farmers to adopt value addition technologies of root and tuber crops.
Keywords: Post harvest losses, Storage practices, Root and tuber crops' farmers

Introduction
One of the major global challenges today is how to ensure food security for a world growing population whilst ensuring long-term sustainable development. According to the FAO, food production will need to grow by 70% to feed world population which will reach 9 billion by 2050 (FAO/OECD, 2011). Furthermore, trends like increasing urban population; shift of lifestyle and diet patterns of the rising middle class in emerging economies as well as climate change put considerable pressure strain on the planet's resources. Consequently, there is a need for an integrated and innovative approach to the global effort of ensuring sustainable food production and consumption (Nellemann et al., 2009; World Economic Forum 2009; Foresight, 2011). While the number of food insecure population remains unacceptably high each year all over the world, massive quantities of food are lost due to spoilage and infestations on their journey to consumers (FAO, 2011; FAO, 2002). In some African, Caribbean and Pacific ACP countries, where tropical weather and poorly developed infrastructure contribute to the problem, wastage can regularly be as high as 40-50% (SPORE, 2011). Increasing food availability does not only entail increasing the productivity in agriculture, there is also a need to lower the losses (Kader, 2005; Parfitt et al., 2010). Food Post harvest losses all over the world is highly significant (FAO and World Bank, 2010; FAO, 2014). A large amount of food and products do not reach the consumers particularly due to post-harvest losses (Kader, 2005; FAO, 2009; FAO and World Bank, 2010). Post-harvest loss leads to an inadequate food intake and it could be manifested by seed loss, monetary loss, food loss and loss of reputation which in turn affect marketing (Gross et al., 2000; FAO and World Bank, 2010). Post-harvest losses can be caused by mechanical damage and injury, physiological processes, poor handling, lack of processing, inadequate packaging, poor logistics and sub-optimal storage conditions (Chakraverty et al., 2003). Quantitative and qualitative losses could occur in crops (Kidane et al., 2006; FAO and World Bank, 2010). Qualitative losses, such as loss in edibility,

nutritional quality, caloric value, and consumer acceptability of the products, are much more difficult to assess than quantitative losses (Kader, 2005; Adeoye, 2009; Buyukbay et al., 2011). Post-harvest losses reduce the availability of food crops and income that could be generated by selling these products. Therefore, quantitative losses are linked to food security (FAO and World Bank, 2010; Hodges et al., 2011) while qualitative losses are related directly to nutrition which are more complicated to measure. However the quantitative losses are of greater importance to measure in developing countries (Humble and Reneby, 2014). It is important to recognize that post-harvest management practices and capacities (not only just production and marketing) are consequential for many reasons including attaining high level of food and nutritional security. Considerable quantities of roots and tubers are transformed into more durable products by drying, fermentation and commination in different combinations and sequences producing a variety of materials each with distinctive characteristics. Other benefits that often accrue from transformation include the removal of toxic substances naturally present and the convenient-to-use nature of the transformed product. Although the ultimate keeping potential is constrained by environmental conditions, transformations have good prospects for long-form maintenance of root/tuber crop supply because they convert a perishable commodity into a more stable form. This study thus, seeks to assess level of post-harvest losses and storage practices of root and tuber crops' farmers in Abia State, Nigeria

Materials and Methods

The study was conducted in Abia State, Nigeria. Abia State lies between longitude 7^0 231 and 8^0 21 E and latitude 4^0 471 and 6^0 and 121 N. Multistage random sampling procedure was used to select 120 respondents. Firstly, two out of the three agricultural zones in the state were randomly selected namely Aba and Umuahia zones. Secondly, two LGAs were randomly chosen from each of the selected agricultural zones giving a total of four LGAs. The third stage involved the random selection of two communities from each of the selected LGAs and finally, fifteen respondents were also randomly selected from each of the communities selected giving a total of 120 respondents.Structured questionnaires were used in the collection of data from the respondents. Data collected were analyzed with descriptive statistics and 5-point Likert-scale.

Results and Discussion

Table 1 shows respondents' awareness and level of adoption of improved ways of storing root and tuber crops in Abia state, Nigeria. The results indicated that majority of the respondents (73.3%) were not aware of the improved methods of storing root and tuber crops mentioned in the table. The table also reveals that the adoption of improved storage practices like use of improved yam barn, use of air-tight and fungicide treated bag, and refrigeration were low in the study area. Table 2 shows farmers' perceptions of the level of post-harvest losses in Root and Tuber crops. The result revealed that farmers perceived that losses in root and tuber crops due to mould and rot, inadequate storage facilities as well as inadequate drying equipment were high while losses due to rodents/insects change in colour/flavor, inadequate transportation system, and traditional processing techniques were moderate. Table 3 which is farmers' perception on the effectiveness of the traditional storage methods of root and tuber crops revealed that traditional barn is not very effective; bags/sacks are not at all effective; Trenches/ Pits are not very effective; Underground storage is not at all effective; Piling the roots in heaps is not at all effective; while heaping under a shade is not at all effective. Since, most of the traditional storage practices adopted by farmers in the state are not effective. There is therefore, the need to encourage farmers to adopt improved ways of storing root and tuber crops. Table 4 shows constraints to the adoption of improved storage practices in Abia state. The respondents perceived that the major constraints to adoption of improved storage practices in the state are Lack of capital (4.33), High transportation cost (4.13), Poor infrastructure like roads (3.98), Lack of awareness of improved storage practices (3.84) while the minor constraints are Epileptic power supply (2.94) and Theft (2.08).

Conclusion

The study revealed a lack of awareness and very low level of adoption of improved ways of storing root and tuber crops in Abia state. The study also identified the major causes of post-harvest losses in root and tuber crops as loss due to mould and rot, loss due to lack or inadequate storage facilities, and loss due to lack of drying equipments.

Table 1: Respondents' Awareness/Adoption of Improved Ways of Storing Root and Tuber Crops

Method	Not Aware	Aware	Interest	Evaluation	Trial	Adoption	Mean	Remark
Improved yam barn	84 (0)	30 (30)	6 (12)	0 (0)	0 (0)	0 (0)	0.35	Low
Air-tight & fungicide treated bag	92 (0)	17 (17)	5 (10)	0 (0)	6 (24)	0 (0)	0.43	Low
Refrigeration	91 (0)	15 (15)	5 (10)	0 (0)	0 (0)	9 (45)	0.58	Low

Source: 2016 survey. Key: 0.01 – 1.00 – Low; 1.01 – 2.00 – Moderate; 2.01 – 3.00 – High

Table 2: Farmers' Perceptions of the Level of Post-harvest Losses in Root and Tuber Crops

Causes of loss	Low	Moderate	High	Mean	Remark
Loss due rodents and Insects	35 (35)	53 (106)	32 (96)	1.98	Moderate
Loss due to mould and rot	26 (26)	61 (122)	33 (99)	2.05	High
Loss due to change in colour and flavour	52 (52)	31 (62)	37 (111)	1.88	Moderate
Loss due to inadequate transportation system	46 (46)	46 (92)	28 (84)	1.85	Moderate
Loss due to lack or inadequate storage facilities	24 (24)	40 (80)	56 (168)	2.27	High
Loss due to lack of drying equipments	32 (32)	39 (78)	49 (147)	2.14	High
Loss due to traditional processing techniques	51 (51)	61 (122)	8 (24)	1.64	Moderate

Source: 2016 survey. Key: 0.01 – 1.00 – Low; 1.01 – 2.00 – Moderate; 2.01 – 3.00 – High

Table 3: Farmers' Perception on the Effectiveness of the Traditional Storage Methods of Root and Tuber Crops

Method	Not at all Effective	Not very Effective	Effective	Very effective	Very much Effective	Mean	Remark
Traditional yam barn	34 (34)	3 (6)	55 (165)	20 (80)	8 (40)	2.71	Not Very Effective
Bags/Sacks	78 (78)	15 (30)	27 (81)	0 (0)	0 (0)	1.58	Not at all effective
Trenches/Pits	60 (60)	32 (64)	6 (18)	0 (0)	22 (110)	2.10	Not very Effective
Underground Storage	43 (43)	60 (120)	3 (9)	14 (56)	0 (0)	1.90	Not at all Effective
Piling the roots in heaps	82 (82)	15 (30)	23 (69)	0 (0)	0 (0)	1.51	Not at all Effective
Heaping under a shade & covering with plantain leaves	32 (32)	63 (126)	25 (75)	0 (0)	0 (0)	1.94	Not at all Effective

Source: Field Survey, 2016

Table 4: Constraint Analysis of Adoption of Improved Storage Practices in Abia state

Constraints	SD	D	U	A	SA	Mean	Rank
Lack of capital	0 (0)	0 (0)	5 (15)	71 (284)	44 (220)	4.33	1st
Lack of awareness of Improved storage practices	0 (0)	22 (44)	18 (54)	37 (148)	43 (215)	3.84	4th
Poor infrastructure like roads	0 (0)	16 (32)	6 (18)	62 (248)	36 (180)	3.98	3rd
High transportation cost	0 (0)	10 (20)	8 (24)	58 (232)	44 (220)	4.13	2nd
Epileptic power supply	10 (10)	30 (60)	45 (135)	27 (108)	8 (40)	2.94	5th
Theft	0 (0)	17 (34)	51 (153)	32 (128)	20 (100)	2.08	6th
Mean score						**3.00**	

Source: Field Survey, 2016

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Evaluation of Heavy Metals Concentration in Leafy Vegetables from Markets in Owerri, Imo State, Nigeria

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Abstract
The study assessed heavy metals concentrations in selected leafy vegetables from Owerri Markets. Five leafy vegetables (Telfairia occidentalis, Talinum triangulare, Occimium grattissimum, Murraya koenigii ,Gnetum Africana) were used for the study. The analysis of the heavy metals concentration was by Atomic Absorption Spectroscopy (AAS), using the standard procedure to determine the concentration of cadmium, lead, mercury, and arsenic respectively. Data generated from samples and WHO\FAO 2011 standard for heavy metals were subjected to test of significance using T-test at 95% confidence level with SPSS (Statistical Package for Social Science). Result shows that mean concentrations of heavy metals were significantly different from FAO/WHO 2011 safe limit. Mean concentrations of Lead, Mercury and Arsenic in vegetables were significantly higher than the safe limit, while mean concentration of Cadmium was lower than the safe limit. It therefore recommended that care should be taken in the production and handling of vegetables to ensure consumption of toxic free vegetables.

Introduction
Leafy vegetables are those vegetables that are cultivated and harvested primarily for the consumption of their leaves, either raw or cooked. Leafy vegetables constitute essential dietary components by contributing vitamins, protein, carbohydrates and other nutrients which are usually in short supply. Furthermore, this component also acts as neutralizing agents for acidic substances formed during digestion (Thompson and Kelly, 2009). However, leafy vegetables are believed to contain metals over a wide range of concentrations (Shaibu et al, 2013). Some heavy metals are either essential nutrients (typically iron, cobalt and zinc) or relatively harmless (such as ruthenium, silver and indium), but can be toxic in larger amounts on certain forms. Other heavy metals such as cadmium, mercury and lead are highly poisonous. Heavy metals are non-biodegradable and persistent environmental contaminants which may be deposited on the surfaces and then absorbed into the tissues of the vegetables (Suruchi and Pankaj, 2011). Heavy metals are absorbed by growing vegetable crops from contaminated soil, water or via exposure to polluted air as a result of human/industrial activities such as mining and industrial wastes, vehicle emissions, lead acid batteries, fertilizers, paints and heated timber, aging water supply-infrastructure, and micro plastics floating in the world's oceans (Orisakwe et al, 2015). Hence there is need to analyzed food items to ensure the level of these trace elements comply with permissible limits. This is why this study aimed to assess heavy metals concentration in leafy vegetables obtained from Markets in Owerri, Imo state, Nigeria.

Materials and Methods
Five leafy vegetables: Fluted pumpkin (*Telfairia occidentalis*), Water leaf (*Talinum triangulare*), Scent leaf (*Occimium grattissimum*), Curry leaf (*Murraya koenigii*), Ukazi (*Gnetum africana*), were bought from three major markets in Owerri; (Relief Market, Amakohia Market and Egbeada Market). They were sundried for a period of five days until they were completely dry. The samples were taken to the laboratory for analysis. The concentrations of Lead, Mercury, Cadmium, and Arsenic in the vegetables were assessed. The analysis of the heavy metals concentration was by Atomic Absorption Spectroscopy (AAS), using the standard procedure to determine the concentration of cadmium, lead, mercury, and arsenic respectively. Data generated from samples

and WHO\FAO 2006 standard were subjected to test of significance using T-test at 95% confidence level with SPSS (Statistical Package for Social Science).

Results and Discussion

The results for the concentration of heavy metals in selected leafy vegetables are presented in Table 1. From the table, lead concentrations in all the vegetables were higher than the safe limit. Same was the case of mercury. Concentrations of Arsenic were also higher than the safe limit except for Telferia occidentalis. Mean concentrations of Lead, Mercury and Arsenic were significantly higher than the safe limit. The result of this study is similar to the findings of Sharma et al (2009), Yusuf and Oluwole (2009), and Maleki and Zarasvand (2008). Yusuf and Oluwole (2009) reported that urban activities result in elevated levels of heavy metals in leafy vegetables. Contaminants in irrigation water and soils also account for high concentrations of heavy metals in leafy vegetables. Concentrations of Cadmium were however lower than the safe limit for all vegetables. Vegetables can absorb metals from soil as well as from deposits on the parts of the vegetables exposed to the air from polluted environments (Khairiah et al., 2004; Al-Jassir et al., 2005; Kachenko and Singh, 2006). Emission of heavy metals from the industries and vehicles may be deposited on the vegetable surfaces during their production, transportation and marketing. Al-Jassir et al. (2015) have reported elevated levels of heavy metals in vegetables sold in the market of Riyadh city in Saudi Arabia due to atmospheric deposition. Sharma et al. (2008) have reported that atmospheric deposition can significantly elevate the levels of heavy metals contamination in vegetables commonly sold in markets. In many developing countries it is a common practice to grow vegetables along banks of rivers passing through urban centres. Waters of such rivers have often been reported to be polluted by heavy metals (Mashauri and Mayo, 2010; Othman, 2011).

Table 1: Concentrations of Heavy Metals (Mg/Kg) in green leafy Vegetables

Plant Samples	Lead (Pb)	Cadmium (Cd)	Mercury(Hg)	Arsenic(As)
	Mean Concentrations and Standard Deviation			
Gnetum Africana (Ukazi)	0.596±0.002	0.127±0.0110	0.820±0.010	0.319±0.010
Telferia Occidentalis (Pumpkin)	0.476±0.100	0.060±0.020	0.111±0.001	0.099±0.001
Talinium Triagulare (Water Leaf)	1.158±0.019	0.080±0.030	0.101±0.001	1.242±0.002
Ocimium Gratisimium (Scent Leaf)	0.739±0.010	0.038±0.011	0.083±0.002	0.881±0.100
Murraya Koenigii (Curry Leaf) `	0.715±0.003	0.064±0.002	0.079±0.010	0.342±0.002
Range	0.476-1.158	0.038-0.127	0.079-0.820	0.099-1.242
Mean+ SD	$0.7368^{a}\pm0.2417$	$0.0738^{b}\pm0.03423$	$0.2388^{a}\pm0.3011$	$0.5766^{a}\pm0.4371$
FAO/WHO Safe Limit (1999&2011)	0.3^{b}	0.2^{a}	0.03^{b}	0.1^{b}
T(0.05)	**P=0.000**	**P=0.000**	**P=0.018**	**P=0.001**

Source: Laboratory Result, 2018. ab mean with same superscript are not significantly different

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Comparative Analysis of the Proximate Nutrient Composition of Shea Fruit Mesocarp, Endocarp and Kernel

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Abstract
The shea tree which has remained neglected with limited nutritional information of the shea fruit has exceptional short, medium and long term prospects for development. The food content including Moisture, Lipid, Protein, Ash, Fibre and Nitrogen free extract (NFE) content of matured shea fruit mesocarp, endocarp and kernel have been studied using standard methods. The proximate content was determined by harvesting the fruits at 20 weeks after flowering and the results recorded. The results from this study show that the mesocarp was highest in moisture (57.50%) and NFE (Soluble carbohydrate, 75.22%); the endocarp was highest in fibre (insoluble carbohydrate, 73.40%) content and the kernel was highest in lipid (56.60%), ash (5.60%) and protein (14.90%) contents. The moisture, lipid, protein and NFE contents of the mesocarp, endocarp and kernels were significantly different ($p < 0.05$) from each other. The ash and fibre content of the mesocarp (5.20% and 8.70%) and kernels (5.60% and 8.00%) were significantly different ($p < 0.05$) from that of the endocarp (0.70% and 73.40%).

Introduction
The shea tree is an indigenous wild tree wood and charcoal used for building and cooking fuel (USAID, cited in Obibuzor *et al*., 2014). The fruit consists of a green fleshy mesocarp, which is sweet when eaten ripe and locally consumed like mangoes (Eneh, 2010) or other wild seasonal fruits. Typically, the fruit consists of mesocarp with nut which houses the kernel. The kernel oil (or fat) is the shea butter. Mbaiguinam (cited in Enabuere, 2007) stated that earlier studies on plant of African savanna parkland (Hall *et al*., 1996) and in Nigeria, the cultivation, exploitation and commercial production of shea and shea butter favours the arid and semi-arid northern parts of the country (Obibuzor *et al*., 2014). The shea tree *Vitelleria paradoxa* is multipurpose and highly valued not only for the economic and dietary significance of its cooking oil, but also for the fruit pulp, bark, roots and leaves which are used in traditional medicines and for the have reported the existence of important nutrients in the shea fruit pulp, normally consumed by the local population to supplement diet from staple foods. The nutritional and economic importance of shea butter has been emphasized over that of the shea fruit. The fleshy shea fruit mesocarp is sometimes fermented, given to animal or left to rot and is discarded in favour of the shea nuts for shea butter production (Enabuere *et al*., 2014). The shea kernel and butter have been well emphasized; the shea mesocarp (pulp) has been less emphasized while little or nothing has been said about the shea endocarp (shell) which houses the kernels and most probably discarded. Consequently, there is the need to exploit the shea fruit mesocarp (pulp) and endocarp (shell) for further usefulness in the food and drug industries. The aim of this study is to determine and compare the proximate composition of shea fruits mesocarp, endocarp and kernel. The proximate composition is based on a system of analysis which divides the food (sample) into six fractions including moisture content (the amount of free water), lipid content (the amount of oil extracted by the organic solvent used), ash content (the amount of minerals), crude protein content (estimated from organic nitrogen content), fibre content (insoluble carbohydrate) and nitrogen free extract (soluble part of carbohydrate).

Materials and Methods

Shea trees were selected and marked for this experiment and shea fruits were harvested from the marked trees in the Nigerian Institute for Oil Palm Research (NIFOR) sub-station, Bida, Niger State at 20 weeks after flowering and analysed for the food content for Moisture, Oil, Protein, Ash, Fibre and Nitrogen free extract contents; upon which data documentation and analysis were done. Before analysis, the shea fruits were peeled to remove the mesocarp and the nuts were cracked to separate the endocarp (shell) from the kernel. The mesocarp, endocarp and kernels were used for the analysis. The mesocarp, endocarp and kernel were dried, powdered and analysed. All reagents used in the analysis were of analytical grade and standard. Percentage moisture was determined using moisture analyser (AND, A&D Company limited, ML-50). Lipid content was obtained by weight difference after extracting the oil with 96% pure n-hexane (Scharau, Spain) in a soxhlet apparatus for 18 hours. AOAC (2010) method was used to measure the ash and nitrogen contents. The ash content was determined by weight difference between the sample and the ash after incinerating the samples in the muffle furnace at 550^0C. The protein content was determined by Kjeldahl method and converted to percentage protein by multiplying with the Atwater factor. Nitrogen free extract (NFE) was calculated by difference using the equation: %NFE = 100 – (%lipid + %ash + %crude protein + %fibre).

The results were gotten in triplicates and subjected to analysis of variance (ANOVA) using SPSS software.

Results and Discussion

The results for the chemical analysis of shea fruit mesocarp, endocarp and kernels are presented in Table 1. The moisture, protein and NFE contents of the mesocarp, endocarp and kernels were significantly different ($p < 0.05$). The moisture content of the mesocarp (57.50%) and kernel (37.70%) in this study was different from that recorded by Mbaiguinam *et al.* (2007) and Enabuere *et al*. (2014) for the mesocarp and Mbaiguinam *et al*. (2007) and Obibuzor *et al.* (2014) for kernels. For mesocarp, Mbaiguinam *et al*. (2007) recorded an average moisture content of 79.03% and Enabuere et al. (2014) recorded moisture contents of 15.35%, 15.54% and 14.94% for Northern Guinea Savanah, Southern Guinea Savanah and Transition Zone respectively. While for kernels, Mbaiguinam et al. (2007) recorded an average of 30.11% and Obibuzor *et al.* recorded 24.03% for whole shea kernels. The lipid content of the kernels (56.60%) was found to be far more than those obtained from the mesocarp and endocarp, and is similar to that obtained by Mbaiguinam *et al*. (2007) and Obibuzor *et al*. (2014). Mbaiguinam *et al*. (2007) obtained an average of 55.94% and Obibuzor et al. (2014) 51.52% for ungerminated shea kernels, while the lipid content of the mesocarp (4.30%) was different from that obtained by Enabuere et al. (2014) for Northern Guinea Savanah, Southern Guinea Savanah and Transition Zone (19.01%, 18.98% and 11.13% respectively). This perhaps explains why the shea fruit is valued more for its oil (which is extracted from its kernels). The ash and fibre content of the mesocarp and kernels were significantly different ($p < 0.05$) from that of the endocarp. The ash content obtained from this study for mesocarp (5.20%) was similar to that reported by Enabuere *et al*. (2014) for Northern Guinea Savanah, Southern Guinea Savanah and Transition Zone (5.5%, 5.1% and 6.9% respectively). and to that of some of varieties (Komane, 5.97% and Kiankos, 5.40%) studied by Mbaiguinam *et al*. (2007) but however, the kernel ash (5.60%) was different from that of Obibuzor *et al*. (2014) for ungerminated (3.10%) and whole shea kernels (2.85%). The protein content for the mesocarp (6.58%) and kernels (14.90%) were different from those reported by Mbaiguinam *et al*. (2007) and Obibuzor *et al*. (2014) but similar to that reported by Enabuere *et al*. (2014) for mesocarp from Transition Zone (6.29%). Mbaiguinam *et al*. (2007) reported an average of 4.38% and Obibuzor *et al.* (2014) 8.58% for ungerminated and 3.87% for whole shea kernels. The fibre content of the mesocarp (8.70%) was similar to that reported by Enabuere *et al*. (2014) for the Southern Guinea Savana (9.8%). There was no report of fibre content of kernels and mesocarp record by Mbaiguinam *et al*. (2007) and Obibuzor *et al*. (2014). The fibre (insoluble carbohydrate) content was highest in the endocarp (73.40%) while the NFE (soluble carbohydrate) was highest in the mesocarp (75.22%) in this study. Variations of some of the results obtained in this study from those of Enabuere *et al*. (2014), Obibuzor *et al*. (2014) and Mbaiguinam *et al*. (2007) may be due to a combination of factors ranging from the location where samples were collected, the variety of shea fruits used for the analysis and others.

Table 1: The results for the proximate nutrient composition of shea fruits mesocarp, endocarp and kernel

Parameter (%)	Mesocarp	Endocarp	Kernel
Moisture	57.50±0.06	16.90±0.06	37.70±0.06
Lipid	4.30±0.05	2.00±0.12	56.60±0.36
Ash	5.20±0.06	0.70±0.10	5.60±0.00
Protein	6.58±0.02	0.86±0.02	14.90±0.05
Fibre	8.70±0.10	73.40±0.15	8.00±0.10
NFE	75.22±0.15	23.04±0.22	14.9±0.05

Note: mean±SD (n=3)

Conclusion

Results from this study revealed that the protein and ash content of the shea fruit was highest in kernel, suggesting that it can satisfy other nutritional purposes apart from the popular shea butter it is commonly processed for. The proximate composition of the mesocarp shows that it constitutes a dietary contribution for its consumers as it is especially high in carbohydrate. Further research should be carried out on the end use and value added products of the mesocarp, kernels and endocarp of the shea fruits respectively, to bridge the knowledge gap here in particular for the much less studied part – the endocarp.

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SUB-THEME 10


AGRICULTURAL EXTENSION,
ADMINISTRATION,
COMMUNICATION AND
RURAL DEVELOPMENT

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Information Sources and Benefits among Artisanal Fisher Folks in Lower River Benue, Makurdi, Benue State, Nigeria

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Abstract

The study assessed information sources and benefits among artisanal fishers in lower river Benue Makurdi, Benue State, Nigeria. Random sampling technique was used to select two hundred and fifteen respondents (80%) from a list of 269 registered fishers in two landing sites – Wadata and North Bank in lower River Benue while structured questionnaire was administered to the respondents. The data collected were analyzed using frequency counts and percentages. The results showed that 26.6% of the respondents indicated radio and television as formal sources of information, 61.4% contacted fishermen as their informal source of information while 48.4% contacted friends. Purchase of fish inputs (61.9%) and more catches (36.7%) are benefits of information sources. Inadequate extension agents (67.0%) and language barrier (48.8%) are constraints to information sources. The study therefore recommends that various information sources should be strengthened by government for effective dissemination to artisanal fishers and employs more extension agents who would be effective in communicating in local language understood by the artisanal fishers.

Keywords: Artisanal, benefits, constraints, information and sources

Introduction

Fish is a source of high quality and cheap animal protein essential to balancing diet. The primary source of animal protein for more than 50% of the world's population is fish. Globally, most of the total fish supply is obtained from marine and inland capture fisheries, and the remainder is derived from aquaculture (Setsoafia *et al*, 2017). Fish production in Nigeria comes from three sources; artisanal (inland rivers, lakes, costal and brackish water), aquaculture (fish farm) and industrial fishing (Otubusin, 2011). However, the vast majority of the fish supply in most cases comes from the artisanal sub-sector. Fish production in Nigeria has not been consistent in all the sources: artisanal inland, aquaculture and industrial fishing (Chilaka, 2014). Artisanal fisheries contribute significantly to the populace in terms of income earning, food security, employment generating there by reducing rural urban movement of people looking for job. However in Nigeria, artisanal fisheries are on a subsistence level because it is made up of low technology and on a small scale. Food sufficiency through transformed agricultural programmes as advocated by the government can only be achieved when the producers in various segments of agriculture receive the right information at the right time on input supply, modern production methods, storage and marketing (Ogunremi *et al,* 2017). Information source in agriculture could be an individual, group or institution that creates or brings a message to the potential end user with the intention of increasing production or improving their welfare. Information sources are channels through which message is disseminated to the targeted group. Information source to an institution or individual is a means of creating or bringing a message that will be useful in tackling occupational challenges (Annune *et al,* 2014). Information source is essential to artisanal fishers because it determines to an extent its availability to the end users who are believed that if reached it will impact positively on their level of production. The study therefore aimed at identifying information sources and benefits among artisanal fishers in lower river Benue, Makurdi, Benue State, Nigeria. The specific objectives are: (i) identify formal sources of information among artisanal fishers. (ii) Investigate informal sources of information among artisanal fishers (iii) determine the benefits of information to the respondents (iv) ascertain constraints to information sourcing among the respondents.

Materials and Methods

The study was carried out in Makurdi, Benue State which has a landmass of about 32,518 km^2. It lies between longitudes 7º47' and 10º East and latitudes 6º25' and 8º North and shares boundaries with Nassarawa State to the North, Taraba to the East, Cross River to the South, Enugu to the South West and Kogi to the West (Federal Government of Nigeria, 2007). It also shares a common boundary with the Republic of Cameroon on the South Eastern stretch. The list and addresses of 269 registered artisanal fishers in two landing sites – Wadata and North Bank in Makurdi was obtained from Benue State Agricultural Development Programme (BESADP). Simple random sampling technique was used to select 80% (215) of the artisanal fishers from the list. A structured questionnaire and interview scheduled were used to obtain information from the artisanal fishers (Ogunremi, *et al.,* 2017b). Data from the study were analyzed using the descriptive analysis such as frequency counts and percentages.

Results and Discussion

Table 1 indicated that 26.6% of the respondents indicated radio and television as major formal sources of information. Radio is mostly accessible to most rural dwellers in Nigeria because it could be powered with batteries when there is power failure. Radio communication is one of the fastest, most powerful and the most popular used means of communication with the rural farmers. It defeats obstacles faced by extension workers (Okeke et *al,* 2015). Research institutes with 2.3% as formal source of information is an indication that researchers had little contact with artisanal fishers. This is not encouraging because researchers are supposed to disseminate findings to the end users who should benefit from their findings.

Table 1: Formal sources of information among artisanal fishers

Variable	Frequency	Percentage
Extension agents	17	7.9
Research Institutes	5	2.3
Radio and Television	56	26.6
Print	26	12.1
No response	117	51.6
Total	215	100

Source: Field Survey, 2017

Table 2 showed that 61.4% respondents contacted artisanal fishers as their informal source of information, 48.4% through personal experience and 29.8% through friends. Information sourcing is usually easier among people of same profession while personal experience overtime could assist an artisan as information source which could help in taken right decision on the profession for maximum productivity. If dissemination of information is effective, information made available to artisanal fishermen will spread like wide fire to all colleagues to enable them improve on their production rate as well as maintain adequate fish supply to the citizens.

Table 2: Informal sources of information artisanal fishers

Variable	Yes		No	
	Frequency	Percentage	Frequency	Percentage
Personal experience	104	48.4	111	51.6
Contacting fishermen	132	61.4	83	38.6
Customers	4	1.9	211	98.1
Friends	64	29.8	151	70.2
Neighbors	12	5.6	203	94.4
Total	215	100	215	100

Source: Field Survey, 2017

Purchase of fish inputs (61.9%), more catches (36.7%) and prevents fish spoilage (21.9%) are major benefits of information gathered by the respondents. Efficiency in production is determined to a large extent on the input available which is dependent on right source of information for its availability. An artisan makes more money through more catches when available information source is accurate and timely. The level of fish spoilage can be greatly reduced with adequate information source on various methods of its prevention.

Table 3: Benefits of information gathered by the respondents

Variable	Benefited		Not benefited	
	Frequency	**Percentage**	**Frequency**	**Percentage**
More Catches	79	36.7	136	63.3
More Income	5	2.3	210	97.7
Marketing	12	5.6	203	94.4
Improve my hygiene	23	10.7	192	89.3
Safety on water	5	2.3	210	97.7
Control of water weed	3	1.4	212	98.6
Prevents fish spoilage	47	21.9	168	78.1
Purchase of fish inputs	133	61.9	82	38.1
Business expansion	6	2.8	209	97.2
Relationship with government	3	1.4	212	98.6
Relationship with NGO	26	12.1	189	87.9

Source: Field Survey, 2017

Inadequate extension agents (67.0%), language barrier (48.8%) and wrong timing of information dissemination (25.1%) were indicated by the respondents as constraints to information sourcing among the respondents in table 4. Extension agents are responsible for the dissemination of research findings to the artisanal fishers; they actually serve as link between the researchers, government and artisans. Whenever this link is weak it affects the production capacity of the end users because is either technology is not made available, wrongly adopted or abandoned which causes a major setback to development. Effectiveness of information lies in the audience ability to understand the message to be passed across in an understandable language. Ability of extension agents to speak the local language improves the acceptability of extension agents as source of information to the end users as they are better able to relate in their local dialect or common language (Ogunremi, *et al*, 2015). Wrong timing of information dissemination would hinder proper planning by artisanal fishers. Statrasts (2004) opined that the characteristics of a good information source are relevance, timelessness, accuracy, cost effectiveness, reliability, usability, exhaustiveness and aggregation level. Access to the right information at the right time in the right format and from the right source may shift the balance between success and failure of the farmer (Opara, 2008).

Table 4: Constraints to information sourcing among the respondents

Variable	Constraints		Not constraints	
	Freq.	**percentage**	**Freq.**	**percentage**
Illiteracy	46	21.4	169	78.6
Language barrier	105	48.8	110	51.2
Extortion from government agencies	7	3.3	208	96.7
Wrong timing of information dissemination	54	25.1	161	74.9
Inadequate extension agents	144	67.0	71	33.0
lack of contact with researchers	39	18.1	176	81.9
Inadequate mobility of extension agents	1	0.5	214	99.5
Distance of community	0	0.0	215	100

Source: Field Survey, 2017

Conclusion

Artisanal fishers indicated radio and television as formal sources of information; fishermen were contacted as their informal source of information and friends. Purchase of fish inputs and more catches are benefits of information sources. Inadequate extension agents and language barrier are constraints to information sources. The study therefore recommends that various information sources should be strengthened by government for effective dissemination to artisanal fishers and employs more extension agents who would be effective in communicating in local language understood by the artisanal fishers.

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Analysis of Impact of Adoption of Sesame Production Technologies on Farmer's Crop Yield among Rural Farmers in Niger State, Nigeria

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Abstract
The study sought to assess the impact of adoption of Sesame production technologies on farmers crop yield among rural farmers in Niger State of Nigeria. Primary data were obtained from the sesame farmers in the state. The total sample size for the study was 245 respondents selected through stratified simple random sampling technique from the three agricultural zones. Primary data were obtained by means of structured questionnaire administered to the respondents. The result was analysed using descriptive statistics like frequency distribution and percentages in respect to farmers' characteristics. The paired sample student t-test was used to analyse test of significant difference in crop yield of before and after adoption. The results revealed that (85.7 %) of the respondents were men, also (60.4 %) of the respondents had between 21-40 years age bracket. The study showed that (43.7 %) of the respondents had household size ≤5 persons with mean of 8. The results of the t-test showed significant difference between crop yield of before and after adoption, the calculated t-value= -6.817 was significant at 5 % level of significance. Based on the results, it is recommended that farmers should be provided with credit and loans to enable them carry out farm work in large scale and government should create more markets to make sale of farm produce easier especially in the rural areas.

Introduction
Sesame is an important crop in Nigerian agriculture which is quite extensively cultivated. It yields in relatively poor climatic conditions and widely used within Nigeria and is an important component of Nigeria's agricultural exports. As a small holder crop, often intercropped with others, the extent of cultivation is poorly known and there is little information on yields or productivity (Abu *et al*., 2012). Beniseed (*Sesame indicum*) belongs to the family *Pedaliacea*. It is commonly called Beniseed in Nigeria. The tiny spherical seeds are edible, having milky flowering flavor. It is an important oil seed believed to have originated from tropical Africa with the greatest diversity (Raw Material Research and Development Council, 2004). Beniseed is a staple food among many ethnic groups in Nigeria and it is cultivated in most areas of the middle belt and some northern States of Nigeria (Olanyanju*et al*., 2006). The Seeds are consumed fresh, dried, fried or when blended with sugar. It is also used as a paste in some local soups. Agricultural research findings meant for farmers' adoption are designed to primarily improve farmers' yield. Study of experts (Agbarevo and Obinne, 2009) have shown that adoption of improved crop production technologies not only significantly improved resource-poor farmers' crop yield but also led to increased farmers' income, which enabled farmers to increase the purchase of production inputs. The fact is that many potential innovations emanating from research do not make it, but those that succeed can have an enormous impact. The broad objective of the study was to analyze the impact of adoption of Sesame production technologies on farmer's crop yield in Niger State, Nigeria.

Methodology

The study was conducted in Niger State, Nigeria. Niger State is divided into 25 Local Government Areas with three agricultural Zones which include Zone A (Bida), Zone B (Kuta) and Zone C (Kontagora) where each Zone is marked with a climate pattern and a defined agricultural system (Nmadu*et al*., 2012). The population of Niger State, Nigeria for 2006 census figure is 3, 954, 772, with a population density of 57 people per square kilometer (Niger State Government, 2011). Agriculture is the backbone of Niger State's economy: 85 % of the population depends either directly or indirectly on it for their livelihood, while others constituting (15 %) are involved in occupations such as white collar jobs, business, craft and arts. Crops grown in the State include cereals (guinea corn, millet, maize and rice), grains and legumes (cowpeas and bambara nuts), root and tubers (yam, cassava and potatoes), oil seeds and nuts (soya beans, sheanuts, groundnut and sesame), fruits (mango, orange, banana, melon, cashew and guava) and fibers (cotton and kenaf). Natural and mineral resources found in the state include talc, gold, silica, marble, copper, iron, lead, granite and limestone. The State is a key source of hydroelectric power, with three dams located at Kainji, Jebba and Shiroro (Niger State Government, 2011).

Data Collection Techniques

Data for this study were collected from primary source. Primary data were collected using a well-structured questionnaire. Trained enumerators who understand and speak the native language were employed in the collection of primary data. The enumerators guided the literate farmers in filling the questionnaire, while the illiterate farmers were asked questions in the questionnaire and answers filled by the enumerators.

Data Analysis Techniques/ Hypothesis Testing

Data for this study were subjected to both descriptive and inferential statistics. Frequencies, percentages and student t-test was used for analyses.

Results and Discussion

Socio-Economic Characteristics of Farmers

Evidence from the descriptive analysis of socio-economic characteristics of respondents in Table 1 showed that majority (85.7 %) of the respondents were males, while (14.3 %) of them were females. This indicates the dominance of males in beniseed production in the study area, which could be due to the tedious nature of farm work that requires enormous strength and energy. This result is consistent with the work of Agwu *et al* (2008) who reported that majority (81.5 %) of the farmers were males in their study. Majority (60.4 %) of the respondents were between 21-40 years old, while (29.4%) were between 41-60 years with mean of about 37years, indicating that most farmers were young and strong. The analysis of the data on the level of education of respondents showed that 42.0 % had no formal education, about 28.2 % had 6-12 years of education while 17.1% and 12.7% had 1-6 years and ≥ 12 years of education, respectively, with mean of about 6 years, implying that farmers in the study area had moderate educational attainment to enable them read and understand extension bulletins. Higher educational level will facilitate the adoption of appropriate agricultural technologies and skills by farmers (Ugbajah and Ugwumba, 2013). The results further showed that 43.7% of the respondents had household size ≤5 persons, while 28.6 % had household size of 6-10 persons with mean of 8persons. This implies that labor force can be sourced within the household. Household size in traditional agriculture determines the availability of labor and level of production (Ani *et al.,* 2004). Majority (72.7 %) of them had farm size ≥ 3.1 hectares of land with mean of 6ha, implying that land area used by farmers in the study area is reasonably large that will enable them to carry out large scale farming that will increase their productivity level. This result is in contrary with the findings of Agwu, *et al.* (2008) who reported that most of the farmers in the country cultivate below 2 hectares.

Table1: Socio-Economic Characteristics of Respondents

Variables	Frequency	%	Mean	Min.	Max.
Sex					
Male	210	85.7			
Female	35	14.3			
Total	245	100			
Age (yrs.)					
≤20	21	8.6			
21-40	148	60.4			
41-60	72	29.4			
≥60	4	1.6			
Total	245	100	37	10	68
Level of formal education (yrs.)					
0	103	42.0			
1-6	42	17.1			
7-12	69	28.2			
≥ 12	31	12.7			
Total	245	100	6	00	35
Household size					
≤5	107	43.7			
6-10	70	28.6			
11-15	42	17.1			
≥ 15	26	10.6			
Total	245	100	8	00	51
Farm size (ha.)					
≤ 1.0	10	4.1			
1.1-2.0	20	8.2			
2.1-3.0	37	15.1			
≥ 3.1	178	72.7			
Total	245	100	6	1	60

Source: Field Survey, (2016)

Impact of Adoption of Sesame (NCRIBEN) Production Technologies on Crop Yield

The results in Table 2 showed the paired samples t-test analysis performed to test the impact of adoption of improved agricultural technologies on farmers' crop yield. Crop yield before and after adoption of sesame production technologies were used to test if there was a significant difference among them. The result showed that there was a significant difference in crop yield of farmers before and after adoption. The calculated t-value= -6.817 was significant at 5 % level thus, the null Hypothesis (Ho) was rejected. This implies that farmers crop yield increases as a result of adopting sesame (NCRIBEN) production technologies, indicating that technologies adoption has positive impact on farmers' livelihood as income from sale of crop can be used to purchase other goods needed by farmers. This result is consistent with the findings of Afolabi (2008) who reported that use of improved agricultural technologies lead to increase in crop yield.

Table 2: The Impact of Sesame (NCRIBEN) Production Technologies on Farmers' Crop Yield using the Paired Samples Student T – Test Statistics Model

	Paired Differences							
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	Df	Sig. (2-tailed)
				Lower	Upper			
Yield before adoption – Yield after adoption	-3.6988	8.4755	.5426	-4.7675	-2.6300	-6.817	243	.000

Source: Computed from field survey, (2016) , t- value -6.817 is significant at 5 % level, df = 24, 2-tailed test

Conclusion

In conclusion, the adoption of sesame (NCRIBEN) production technologies by farmers leads to increase in farm output, In other words, income of farmers increases as a result of adopting the improved technologies introduced in the study area whereby resulting to improved social well-being of the rural farmers. Adoption of improved agricultural technology is unquestionably a means of increasing farm output. Based on the results, it is recommended that farmers should be provided with credit and loans to enable them carry out farm work in large scale and government should create more markets to make sale of farm produce easier especially in the rural areas.

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The Role of Date Palm in the Livelihood of Farmers in Jigawa State, Nigeria

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Abstract
Date fruit (gotten from the Date palm) trade is an important economic activity for many tropical rural areas of the arid and desert regions of the world. In West Africa, date fruit holds high socio-cultural and traditional values. Farmers (traders) hawking date fruits in wheel barrows and on trays are a common sight in Northern Nigeria. The study thus attempted to explore the effect of date fruit marketing on the livelihood of farmers in Jigawa State, Nigeria, in year 2017. Structured questionnaire was used to collect primary data from 82 randomly selected respondents from the study area. Secondary data was collected from relevant literatures. Data was analyzed by means of descriptive statistics. The results of the study showed that a high percentage of the respondents were married (90%) males (96%) above 30 years of age (84%). All of them were of the Muslim faith (100%) and a fair number of them had western education (64%). Although the respondents had a good grasp of their trade, (82% of them had up to 6 years of experience in date fruit marketing), the farmers were relatively poor with farm holdings of not more than 5 acres (82%) and an annual income of not more than N200 000 (87%). As a result, 67% of the respondents had other sources of income to help carter for their large family size of above 5 persons (84%). Among the important problems of date farmers/marketers include; pest/diseases and low shelf life of the fruit (52% each) and poor financial condition of the farmers (50%). Nigerian Institute for Oil Palm Research (NIFOR) through its sub-station in Dutse has released improved date palm planting materials to farmers and helped in educating and encouraging farmers to cultivate the crop. The date palm has so many applications both health wise and nutritionally, yet its potentials are highly underutilized in Nigeria giving rise to poor performance of farmers in the sector.
Keywords: Date palm, Livelihood, Marketing, Farmers, Concentrated and Sparsely

Introduction
Phoenix dactylifera, commonly known as date palm is a diploid, perennial, dioeciously and monocotyledonous flowering plant species in the family, Arecaceae. It is cultivated for its edible sweet fruit. Although its place of origin is not quite known, it is generally believed to have originated from Iraq (Morton,1987; Khushk et al, 2009; Ata et el, 2014). The date palm is an important economic tree crop that thrives in arid/desert regions of the world, including the Northern parts of Nigeria (Jigawa, Zamfara, Kastina, Borno, Sokoto, Kano, Bauchi, Yobe, Plateau, etc). It is interesting to note that there are more than 199 different types of date fruits, yet they are all very nutritious and have lots of vitamins (A, B and D) and sugar (fructose) which makes them a great source of nutrient and energy (Divya, 2015; El-Sohaimy &Hafez, 2010). The date fruit can be consumed fresh, dry, pitted and candied, in sweet dishes, savory dishes and cookies, wines, syrups, animal feeds, etc. Nutritionally, dates contain natural fiber and lots of other nutrients like oil, calcium, magnesium and more (Al-Gboori & Krepl, 2010). Health experts said dates are easily digestible and contain simple sugars like glucose, fructose and dextrose which are sources of instant energy. Dates are also rich in ingestible fiber which makes them a good laxative for the treatment of constipation (Al-gboori & Krepl, 2010). The Nigerian Institute for Oil Palm Research, (NIFOR), a Research Institute established in 1939 near Benin City with the mandate of researching into the genetic improvement of its mandate crops (oil palm, coconut palm, Raphia palm and date palm and recently other crops like Shea and jojoba), improvement in their methods of cultivation and ways of tapping their vast potentials has released improved elite date palms to farmers. Date palm provides food, shelter, timber, income and employment to

farmers. Dates are major food sources and income for local populations in the Middle East and North Africa, and play significant roles in their economies. In Nigeria, date palm is of great socio-economic importance as it provides a wide range of products and services to the populace, especially the local people (Anon, 2005; Mahmoudi *et. el*, 2008). In addition to serving directly as food sources, dates are packed and processed in a number of ways, and other parts of the tree are used for various purposes in both households and commercial settings and these provide substantial returns to farmers (Anon, 2005; Hassan *et. el*, 2006). The study therefore, attempts to investigate the effect of date palm production and marketing in the livelihood of farmers in Jigawa (a highly concentrated date palm growing area) and Plateau (a sparsely concentrated date palm growing area) States of Nigeria. However, due to financial limitation, the study was limited to Jigawa State. The study is fueled by the research gap on the effect of date palm production and marketing in the livelihoods of farmers in Jigawa State, Nigeria.

Methodology

The study was conducted in Jigawa State of Nigeria. The choice of the State was based on the premise that it is one of the date palm concentrated states in Nigeria and it is also where the NIFOR Sub-Station for date palm research and production is established. The presence of the Research Institute in the State; has greatly improved the awareness of the importance of date palm in Northern Nigeria as well as help promote its cultivation in the country. Jigawa is a State in North Central Nigeria. Its capital City is Dutse. Multistage random sampling technique was used in selecting respondents for the study. This was to ensure that the selection of respondents was unbiased and a true representative of the population. In the first stage selection, Jigawa State was purposively selected because it was one of the densely populated dates growing States in Nigeria added to the fact that NIFOR's date palm sub-station is located in the State capital. A total of hundred (100) date farmers were randomly selected for the study. Pre-tested structured questionnaires were used to source primary data from respondents while scientific journals and other related articles were used for secondary data collection. However, of the hundred (100) questionnaires administered, only ninety (90) were successfully retrieved while eighty two (82) questionnaires were correctly filled. Data was analyzed by means of descriptive statistics and gross margin analysis.

Results and Discussion

Socio-Economic Characteristics of farmers

Sex

The sex distribution of the respondents (Table 1) indicated that about 96% of the respondents were male implying that the business of farming and marketing of date fruits was largely reserved and dominated by males in the study area. The tediousness of a farm process coupled with the cultural and/or religious settings of a particular group of people help to determine the gender distribution of its citizens in relation to a given task.

Table1: Sex Distribution of the Respondents

Sex	Frequency	Percentage
Male	79	96.3
Female	3	3.6
Total	**82**	**99.9**

Source: Field survey, 2017

Age

It is generally believed that with increase in age, an individual becomes mentally mature and takes rational decisions. The age of the respondents is as shown in Table .

Table 2: Age of Respondents

Age of respondents	Frequency	Percentage
Young (up to 30)	13	15.8
Middle aged (31-50)	39	47.5
Old (above 50)	30	36.5
Total	**82**	**99.8**

Source: Field survey, 2017

The age distribution of the farmers show that about 48% of them were middle aged, followed by 37% elderly (old) farmers and the least percentage was the young farmers (16%). This result is similar to those of Salman (2009) and Abbas (2010), that most farmers belong to the middle age and old age group. Invariably, the business of farming and marketing of date fruits is for matured adults who can initiate and execute business plans and actions. They are able to take decisions that are well guided based on past experiences and not on impose as younger people.

Marital Status

Table 3 above showed that less than 10% of the farmers were single while about 90% of them were married implying that the farmers were responsibly and had a high capacity to access and adopt productive innovations that would increase their productivity in other to support their families and provide their basic needs. This refers to any of the distinct options that describes a person's relationship with a significant other. It could be married, single, divorced, separated or widowed (Wesbster Learner's Dictionary). According to Adesope *et. al.* (2012), the marital status of a farmer is an indicator of the responsibility of the farmer and his ability to access information sources for proven agricultural innovations to be adopted for long term sustainability.

Table 3: Marital Status of the Respondents

Marital Status	Frequency	Percentage
Married	74	90.2
Single	8	9.7
Widowed	0	0
Separated	0	0
Divorced	0	0
Total	**82**	**99.9**

Source: Field survey, 2017

Religion

The result of the religious distribution of the respondents is as shown in Table 4 above is quite unique because all (100%) the respondents turned out to be Muslims. This observation could be attributed to the fact that the predominant religion in Jigawa State is Islam and date fruit is widely consumed by Muslims especially during their Ramadan fast (Al-Gboori, 2010). Religion varies from place to place and from tribe to tribe. Over time, religion has played an important role in the selection of food, dressing, occupation and association of people and gender related activities. Religion of a given people therefore affects their cultural, social and economic activities.

Table 4: Distribution of Respondents according to Religion

Religion	Frequency	Percentage
Christian	0	0
Muslim	82	100
Traditional	0	0
Total	**82**	**100**

Source: Field survey, 2017

Education

The result (Table 5) shows that the majority of the farmers had access to western education, followed by about 59% of them with Arabic education. It should be noted however, that most of these farmers had training in both western education and Arabic schooling hence the multiple responses. Regrettably, about 2% of the farmers were illiterates. The implication of this result is that a greater percentage of the respondents would readily adopt any new and innovative agricultural practices released by Research Institutes and recommended by extension workers. Education is an aggregate of all the process of learning to bring about change in the behavior of an individual. It expands knowledge thereby giving an individual the ability to be analytical and logical towards issues. Many studies have shown that education especially formal education plays a significant role in the adoption process of recommended agricultural practices. Education of a person is crucial for his food security and better livelihood (Kim and Wade, 2005).

Table 5: Distribution of Respondents according to their educational level

Type of education	Frequency	Percentage
Non (illiterate)	2	2.4
Arabic	48*	58.5
Western (formal training)	53*	64
Total	**108***	**125.5**

* = Multiple responses
Source: Field survey, 2017

Farmers farm size

The study revealed that 82% of the farmers were relatively poor with farm holdings of less than 6 acres (Table 6). This was followed by 12% with holdings of 6 to 10 acres. Only 6% of the respondents had above 10 acres of farmlands. This result is in accordance with that of Badar et al. (2007) and Ata et. el. (2014), who stated that majority of farmers, especially in developing countries, are poor and have small land holdings. This result, therefore, suggests that the respondents may not readily access agricultural innovations nor have the will power to take huge giant steps into the unknown by forsaking their forefathers' method of farming for latest trends in agricultural technology as suggested by the study of Salman (2009). The size of farm holding of a farmer refers to the piece of land cultivated by the farmer. It is often assumed that farmers with large farm sizes are richer and quicker in taking risks of adoption of new farming technologies as well as have better access to information on improved farming techniques than farmers with lesser acreages of farmland (Salman, 2009).

Table 6: Distribution of Land Holding (acres)

Total Area	Frequency	Percentage
Up to 5	67	81.7
6-10	10	12.1
11-15	2	2.4
16-20	1	1.2
Above 20	2	2.4
Total	**82**	**99.8**

Source: Field survey, 2017

Annual Income

Table 7 shows that, majority (61%) of the respondents had an annual income of up to a hundred thousand naira (₦100 000). Twenty six percent of them earned a yearly income in the range of a ₦100 000 to ₦200 000. While only 13% of them had a yearly income above two hundred thousand naira. This result suggests that majority (87%) of date palm farmers in the study area were relatively poor (with an annual income of not more than ₦200 000) given the hearse economic situation of the country (inflation) coupled with the exchange rate of a dollar to the Naira in the tune of $1 to ₦350. This observation is in consonance with those of Salman (2009) and Raza (2010), that, most farmers in developing world are small scale and poor, earning little above a hundred thousand naira yearly. The overall income of a farmer earned during a given year is referred to as his annual income for that year. The more income earned by a farmer, the more he is able to expand his business frontier without necessarily venturing into other fields of trade as suggested by Badar et. el. (2007) and the World Bank (2010).

Table 7: Distribution of farmers according to annual income (₦)

Annual income	Frequency	Percentage
Up 100 000	50	60.9
100 001-200 000	21	25.6
200 001-300 000	5	6.0
Above 300 000	6	7.3
Total	82	99.8

Source: Field survey, 2017

Sources of Income

Table 8, showed that 67% of the respondents had other sources of income to augment what they get from their date trade. The implication of this is that the income from date marketing is not sufficient to carter for the financial needs of the farmers. The few (32%) respondents who had no other means of income other than their date farm, probably, had large farm sizes and may be using improved farm technologies to increase their yearly output, hence, earn more income to sustain them and their families. Salman (2009) and Raza (2010), observed that, most farmers in developing world are small scale and poor, earning little above a hundred thousand naira yearly. Therefore, most of these rural farmers prefer to diversify their sources of income to improve on their income.

Table 8: Respondents Sources of Income

Sources of income	**Frequency**	**Percentage**
Have only one source of income (date marketing)	27	32
Have other sources of income (besides date marketing)	55	67
Total	**82**	**99.9**

Source: Field survey, 2017

Family Size

The distribution of the respondents according to household size as shown in Table 9 indicated that a great percentage (84%) of them had very large household of above 5 persons while only a negligible percentage (16%) had household size of 1-5 persons. This result stresses the need of the respondents to be more productive through diversification of income sources in other for them to be able to meet up with their family needs. Family size of the respondents is an important indicator that influences livelihood and labor force of the farmer. Generally, the larger a farm family size, the poorer the farm household due to more mouths to feed, educate, and carter for. On the other hand, the larger a farm household, the greater the labour force available to work on the farm, hence more output before the law of diminishing returns sets in.

Table 9: family size

Household Size	Frequency	Percentage
1-5	13	15.8
6-10	30	36.5
11-15	22	26.8
16-20	15	18.2
Above 20	2	2.4
Total	82	99.7

Source: Field survey, 2017

Respondents Years of Date Palm Farming

The years of experience of the respondents in the business of date farming and marketing in the study area showed that the highest percentage (45%) of them had between 6-10 years of experience, while about 43% of them had above 10 years farming experience (Table 10). The observation implied that the respondents were well vested in the intricacies of date fruit production and marketing. It therefore followed that with the high number of their years of experience and their high educational back ground, they would be assumed to make good informed decisions concerning their business. The longer the length of time spent on a skill, the better the understanding of the workings and applications of the skill. Studies have shown that working experience augments and compliments paper qualification. It is therefore essential that farmers improve their skill by increasing their years of experience on the job.

Table 10: Respondents Years of Date Palm Farming Experience

Years	Frequency	Percentage
1-5	10	12.1
6-10	37	45.1
11-15	13	15.8
16-20	11	13.4
> 20	11	13.4
Total	**82**	**99.8**

Source: Field survey, 2017

Varity of Date Fruit Farmed/Marketed

The most popular date fruits variety sold in Jigawa State include the Dan Agadez, Dan Mali and the Dan Hausa. The Dan Agadez and Dan Mali are imported from Niger Republic and Mali respectively, while the Dan Hausa is indigenous to Nigeria. Dan Hausa has about five different species which include: zabia which is big in size and looks like the Saudi Arabian Ajhuwan date. It is sweet and full of fiber but expensive (it is believed to be of high quality). Farin Dabino has small seed, full of fiber and second to zabia in quality while Takanda is big in size and somewhat greenish at ripened stage (it is believed to be lower in quality). Loko is the sweetest amongst them all. It is soft, moist and has a small seed while Kaju is yet specie with two different formations at a ripened stage. One end dries up while the other side looks yellowish and full of moisture (very low quality).

Table 11: Variety of Date Farmed/Sold by the Respondents

Variety	Frequency	Percentage
Dan Hausa	82	100
Dan Agadez	5	6.0
Dan Mali	15	18.2
Total	**125***	**151.8***

*multiple responses
Source: Field survey, 2017

The responses of the farmers and marketers of date fruit in the study area is as shown in Table 11. All the respondents (100%) traded in Dan Hausa, while, a negligible few, (6% and 18%), still traded Dan Agadez and Dan Mali respectively. This is most probably because the demand for Dan Hausa is higher because it is maggot free, soft and full of fiber; resulting in higher price per unit sold. The rapid growth of date in Northern Nigeria is reducing the mass importation of Dan Agadez and Dan Mali. The release of Dan Hausa by NIFOR sub-station in Jigawa State has helped to conserve the national income as well as provide healthier food for the populace in the stead of popular Dan Agadez and Dan Mali that are usually imported as consignments with one form of maggot or the other due to long periods of storage. At present Dan Hausa is also competing with dates from Saudi Arabia (Ajhuwan date). This is because the Dan Hausa enjoys a comparative advantage over the imported dates of being softer, full of fiber and most importantly free of maggots whereas the imported dates are hard to crack and chew and are also maggot infested.

Planting Season

Table 12 showed that only 72 out of 82 respondents responded to this particular question. All (100%) the respondents as shown in Table 12 above agreed that the best planting time for date palm in the study area was at the onset of the rains. There was however a disagreement concerning the peak season for date as about 41% of the respondents said it was abundant during the rains while more than 58% of them were of the opinion that the date fruit was most abundant during the dry season. Also, about 65% of them were of the believe that the lean season for date was during the dry season, while about 35% believed otherwise. In conclusion however, it was gathered that there are different species of date palm and their peak and lean seasons may vary according to seasonal changes.

Table 12: Best Planting Season for Date in Jigawa State

	Raining Season		Dry Season	
Season	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Best planting period	72	100	0	0
Peak season	30	41.6	42	58.3
Lean season	25	34.7	47	65.2
Total	**127**	**176.3**	**89**	**123.5**

Source: Field survey, 2017

Table 13: Age of Date Palm at Maturity

Age Range (years)	Frequency	Percentage
1-5	31	37.8
6-10	41	50.0
11-15	10	12.1
Above 15	0	0
Total	**82**	**99.9**

Source: Field survey, 2017

Fifty percent of the respondents were of the opinion that it takes between 6-10 years for the date palm to start fruiting while about 38% of them believed that the palm can start bearing even within the first five years of planting (Table 13). Again this may be dependent on the variety of the date palm planted.

The Table above (Table 14) showed that the greatest problems of date farmers/marketers include; pest/diseases (52%), low shelf life of the fruit (52%) and poor financial condition of the farmers (50%). These are very critical since apart from reduction of value of the dates harvested due to pests and disease attack, the value of the dates further reduces due to spoilage as a result of its low shelf life affecting even more the poor financial situation of the farmers. It is no wonder then that a substantial number of the farmers/marketers source for from other sources (Table 8). From Table 14 above, accessibility of loans from Banks seemed to be another constraint to the farmers/marketers (43%). The implication of this is that the farmers remained subsistent with little room for expansion.

Table 14: Major Constraints/Challenges Faced by the Farmers/Marketers

Constraint	Frequency	Percentage
Access to loan	36	43.9
Pests/diseases	43	52.4
Low shelf life of date fruit	43	52.4
Poor finances	41	50.0
Lack of inputs	13	15.8
Total	**176***	**214.5***

*= Multiple responses
Source: Field survey, 2017

Conclusion

Date palm is a multipurpose tree that provides job, food, shelter, timber, raw materials for industries and income to farmers as well as has a great potential to add to the foreign exchange earnings of the country if its potentials are fully harnessed. The Date palm is thus an important economic tree that fortunately strives well in the central and Northern parts of Nigeria given that the tree thrives in arid and desert regions best. The study showed that Date palm farming and marketing in Jigawa State is not a new phenomenon as many farmers were already into its cultivation. The usage of a wide range of both commercial and household date palm products in the study area was found which indicates the considerable role of date palm in sustainable livelihoods of farmers. However, low shelf life, disease/pest infestation and poor financial backing of farmers were among the bottleneck of the farmers. The presence of the Research Institute for Oil Palm Research (NIFOR) Sub-Station in Dutse has not only helped to improve on the genetics and breed of the Date palm planting materials but also helped to popularize the fruit and its uses.

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Use of Information and Communication Technologies (ICTs) in Enhancing Cassava Production for Food Security in Ogba/Egbema/Ndoni Local Government Area of Rivers State

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Abstract
This study focused on the use of information and communication technologies (ICTs) in enhancing cassava production for food security in Ogba/Egbema/Ndoni Local Government Area of Rivers State. Two specific objectives guided the study and two research questions were developed in agreement with the objectives. Survey design was adopted for the study. The population for the study was all the cassava farmers in the five agricultural zones in the state. A simple random technique was used to select twenty (20) respondents from each of the zones giving a sample size of 100. Instrument for data collection was structured questionnaire, which was validated by a peer review of research validates in the Department of Agricultural Education, Federal College of Education (Technical), Omoku. The researcher and two research assistants administered the questionnaire and the data collected was analyzed using weighted means. The findings from the study revealed that most cassava farmers do not have android, windows phones, tablets, and palm top etc. Most cassava farmers cannot go to cyber café for information, do not have their e-mail address, are not familiar with internet facilities and cannot make use of these ICTs facilities. It was recommended that government should provide ICTs facilities in the rural areas especially in Ogba/Egbema/Ndoni Local Government Area since it is one of the basic blocks for food production in the state.

Keywords: Cassava, food security, information, communication, technology and production.

Introduction
Generally, agriculture is an information-intensive industry. It relies upon continues flow of information from local, regional and world market (Akinbibe and Alabi, 2011). Information and communication technologies (ICTs) are new technologies that cannot be ignored in Africa especially for development in all sectors, agriculture inclusive. This is because (ICTs) is one of the main driving forces that can bring about development and change in this present digital age (Olaniyi, Adetumbi and Adereti, 2013). The recent development in ICTs has broken national and international barriers and turned the world into a global village, making information available to everyone, everywhere and at any time it's needed (Onasanya, Shehu, Ogurilade and Adefuje, 2011). ICTs are technologies that facilitate communication, processing and storing of information through electronic means. ICTs can also play important role in bringing about sustainable cassava development when use to document both modern and traditional cultivation practices. There are still very serious limitations in (ICTs) application, particularly in the study area despite world–wide ICTs revolution, these limitation according to Arokoyo (2011), includes; low level of ICT readiness, poor ICTs infrastructures, erratic and unstable power supply, limited and high cost of telephone service, limited access to computers and internet , lack of communication policy by Government, high level of rural poverty, high level of illiteracy etc. given, the urgent need for current agricultural knowledge and information system (AKIS) by cassava farmers in Ogba/Egbema/Ndoni Local Government Area, the use of farm radio, home visit and contact farmers for extension information delivery is counterproductive. These therefore, calls for the

use of (ICTs) by cassava farmers in the study area because Nigeria remains the world leader in cassava production with the annual output ranging from 30 to 40,000,000 metric tons which production is in the hands of small scale farmers. Cassava production has increased over the years because of its multifarious uses as starch rich root (Karim, Fasasi and Oyeyinka, 2008). Cassava production has been transformed from being a staple food to a source of income as well (Olaniyi, *et. al,* 2013). In submission of Erhabor and Emokaro (2007).

There has been tremendous increase in the current cassava output in Nigeria in order to meet the increasing demand both locally and internationally. In the light of the above, Adekanye, Ogunjimi and Ajala (2013) and Okune, Shittu, Olarewaju, Tolorunju and Afolabi (2004), succinctly opined that cassava production activities have the potential to improve the nation's economy as Nigeria has been consistently ranked as the world's facilitating largest producer. Increasing cassava farmer's productivity and income will require the development of appropriate technology through research and the transfer of research output through extension systems (Abalu, 1998). Promoting productivity among cassava farmers is therefore essential for national growth and food security in Nigeria. This is because how far farmers progress in whatever they do depends largely on the awareness, accessibility, utilization and relevance to accurate and reliable information. However, there is still dearth of knowledge and information and new technologies in agriculture that is yet to be exploited in the study area. Therefore, access to such new information is a crucial requirement for sustainable agricultural development especially in cassava industry as the 'wheel' of economic activities since it facilitates the economic growth and food security (Balderam, 2009). This study has no doubt that, despite the world-wide (ICTs) revolution, there are still very serious limitations in (ICTs) application and utilization in Ogba/Egbema/Ndoni Local Government Area. It was on this note that the study was designed to investigate the use of information communication technologies (ICTs) in enhancing cassava production for food security in Ogba/Egbema/Ndoni Local Government Area of Rivers State. The objective of the study was to ascertain the level of (ICTs) awareness among the cassava farmers in the study area and identify the constraints to the utilization of (ICTs) by the cassava farmers in ONELGA.

Methodology

This study adopted survey design; questionnaire was used to collect data from respondents which findings were generalized upon the entire population. The population of the study was all the cassava farmers in the five agricultural zones in the state. A simple random technique was used to select twenty (20) farmers from each zone which gave a total sample size of 100. The instrument used for data collection was structured questionnaire which was constructed on a 4 – point measuring scale of strongly agree (SA) = 4, Agree (A) = 3, Disagree (DA) = 2 and Strongly Disagree (SDA) = 1. The questionnaire was validated by a peer review of research validates in Department of Agricultural Education, Federal College of Education (Technical), Omoku. The questionnaire was administered to the farmers by the researcher and two research assistants. The rationale of using research assistants was to ensure easiness of administration and collection. The data collected was analyzed using weighted mean. Mean equal or above 2.50 was accepted while mean below 2.50 was rejected.

Results and Discussion

The result in Table 1, item 1 showed a mean score of 1.90 which implies that most cassava farmers do not have Android, Window Phones, Tablets, Palm Top etc. Item 2 with the mean score of 2.09 showed that cassava farmers do not go to cyber café for information. Item 3 showed that most of the cassava farmers do not have their e-mail addresses with the mean score of 2.10. Item 4 gave a mean score of 1.71 which implies that Cassava farmers are not familiar with internet facilities. Finally, the data in item 5 showed that cassava farmers cannot make use of these ICT facilities with the mean score of 1.94. Thus, it is accepted that cassava farmers in the study area do not have the awareness of ICT facilities regarding their cassava production. The findings is supported by Arokoyo (2011), stated that despite the importance of ICTs to agriculture, rural farmers in Nigeria, including cassava farmers have not been able to substantially adopt them to increase productivity. Reasons advanced for this scenario include; farmers not been familiar with internet, non ownership of ICT facilities by some farmers, low level of ICT readiness, poor ICT infrastructure, erratic and unstable power supply, limited and high cost of telephone services, limited access to computers and internet facilities, lack of communication policy by government, high level of rural poverty, high level of illiteracy, policy inconsistency and commercialization of radio stations, among others.

Table 1: Mean responses on the level of ICTs awareness among cassava farmers in the study area

S/N	Items	SA	A	D	SDA	Total	$\bar{x}$	Decision
1.	Most cassava farmers have Android, window phones, tablets, palm top etc.	10	15	30	45	100	1.90	Rejected
2.	Cassava farmers go to cyber café for information	11	18	40	31	100	2.09	Rejected
3.	Most of the cassava farmers have their e-mail addresses	12	13	48	27	100	2.10	Rejected
4.	Cassava farmers are familiar with internet facilities	9	12	20	59	100	1.71	Rejected
5.	Cassava farmers can make use of these ICT facilities	12	14	30	44	100	1.94	Rejected

Sources: Field survey, 2018

The result in table 2, item 6 with the mean score of 3.07 revealed that most cassava farmers cannot access ICTs facilities on their own, item 7 with the mean score of 1.50 shows that electricity is a problem to ICTs utilization, item 8 with the mean score of 3.54, indicated that most cassava farmers cannot access ICTs because of the high cost, item 9 with mean score of 3.41 showed that most cassava farmers have no knowledge of ICTs in their production, item 10 revealed that most cassava farmers do not have interest in ICTs with mean score of 3.53, while item 11 with mean score of 3.42 revealed that most cassava farmers are illiterate and do not know about the relevance of ICTs to their farming business. Finally, item 12 revealed that high cost of leaving is a bearer to ICTs usage to cassava production with the mean score of 3.61. The result is in line with the report of Bertolini (2004), who had earlier observed that several obstacles hinder ICTs usage in developing countries, especially in area of accessing (ICTs) facilities and illiteracy. Therefore, a lot has to be done in order to incorporate ICTs utilization in agriculture in the study area.

Table 2: Mean responses on the constraints to the utilization of ICTs among the cassava farmers in the study area

S/N								
6.	Most cassava farmers cannot access ICTs facilities on their own	39	35	20	6	100	3.07	Accepted
7.	Electricity is a problem to ICTs utilization	1	0	47	52	100	1.50	Rejected
8.	Most cassava farmers cannot access ICTs because of high cost of facilitiess	62	30	8	-	100	3.54	Accepted
9.	Most cassava farmers have no knowledge of ICTs in their production	60	26	9	5	100	3.41	Accepted
10.	Most cassava farmers do not have interest in ICTs	60	33	7	-	100	3.53	Accepted
11.	Most cassava farmers are illiterate and do not know about the relevance of ICTs to their farming business	54	35	10	1	100	3.42	Accepted
12.	High cost of living is a barrier to ICT usage in cassava production.	70	21	9	-	100	3.61	Accepted

Source: Field survey, 2018

Conclusion

Based on the findings of the study, it could be concluded that the level of ICTs awareness of cassava farmers in the study area is very low. The use of ICTs facilities is not encouraging in the study area because of this, the relevance of these facilities are not felt by the cassava farmers. Also illiteracy, high cost of facilities and cost of high living standard are problems that need to be addressed if cassava production is to be sustained in the study area. Government should therefore help to provide ICTs facilities in the rural areas which are the basic block of food production in the country in order to achieve food security. Rural training on the use of ICTs should be made available and affordable to the cassava farmers in the study area. There should be new techniques and methods of cassava production through seminars, television and radio to enable cassava farmers participate and practice new innovations for food security in the country. Power supply should be stable and made to reach the rural area which is the hallmark of food production for better living standard.

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Constraints to Youth Participation in Agricultural Enterprises in the Central Agricultural Zone of Nasarawa State, Nigeria

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Abstract
The study examined the constraints to youth participation in agricultural enterprises in the Central Agricultural Zone of Nasarawa State, Nigeria. The broad objective was to examine the factors limiting youth participation in agricultural enterprises in the study area. Multistage sampling procedure was used to select 120 youths as study sample. Questionnaire was used to elicit information from the respondents. Data were analyzed with descriptive statistics such as percentages, mean scores and ranking. Results show that majority (60.8%) of the respondents were males; majority (94.2%) were within the ages of 21 - 40 years; mean age of the respondents was 30 years. Most (85.8%) of them had one level of formal education or the other. Their average year of farming experience was 11years. The mean farm size of respondents was 5hectares while the mean annual income was N402, 250.00. The predominant agricultural enterprises undertaken by the respondents were- crop farming, livestock farming, farm produce processing and marketing. The major constraints to youth participation in agricultural enterprises were inadequate capital (86.7%), inadequate credit facilities (70.0%) and high cost of farm inputs (65.8%). It was recommended that agricultural credit facilities should be made more flexible to young people who want to go into agricultural enterprises.

Introduction
Agriculture remains fundamental to poverty reduction and economic growth in the 21st century since 75% of the world's poor live in rural areas involved in farming (World Bank, 2008). In Nigeria agriculture provides about 40% of the Gross Domestic Product (GDP) as well as employment and income to 70% of the rural population. Specifically, agriculture provides food for the people, raw materials for the industries and foreign exchange for the country (Olarenwaju, 2010). Youths have been differently defined by various authors worldwide. According to the Nigeria National Youth Development Policy (NYDP, 2009), a youth is described as any person between the age of 18 and 35 years. This stratum of the Nigeria population make up 80 percent of the total population and constitute about 76 percent of the agricultural labour force. Agricultural enterprise refers to small scale agriculture and other agro-business activities undertaken by individuals in order to earn a living. Agricultural enterprises include: crop farming, livestock farming, fish farming, agricultural produce marketing, feed production, agricultural produce processing, horticultural production, poultry production, and agro-chemical inputs sales among others (Afande *et al.,*2015). Youths are the successor farming generation and therefore the future of food security in Nigeria. The ageing smallholder farmers are less likely to adopt the new technologies needed to sustainably increase agricultural productivity hence the need to encourage youth participation in agricultural enterprises. A lot of agricultural enterprises abound in Nasarawa state that can provide gainful employment opportunities for the teaming youths and yet many of the rural youths are still unemployed. There is also general youth apathy towards agricultural enterprises. The need to scientifically assess the reasons behind this youth apathy to agriculture in the state is the knowledge gap this study seeks to fill. The purpose of this study is to identify the constraints to youth participation in agricultural enterprises in the Central Agricultural Zone of Nasarawa State, Nigeria.

Methodology

The study was conducted in the central agricultural zone of Nasarawa state, Nigeria. The Central agricultural zone comprises of four (4) Local Government Areas (LGAs) namely; Akwanga, Nasarawa Eggon, Wamba and Kokona. A multi-stage sampling procedure was used to select a sample of 120 respondents from three (3) LGAs within the agricultural zone namely Akwanga, Kokona and Nasarawa- Eggon. Method of data collection was through the use of a structured questionnaire. Data were analyzed using descriptive statistics such as percentages, mean scores and ranking.

Results and Discussion

Socio-economic characteristics of the respondents

Table 1 shows the distribution of the respondents according to their socioeconomic characteristics. Majority (94.2%) of them were within the age range of 21-40 years. The mean age of the respondents was 30 years. This implies that the respondents were very young and energetic people who can undertake agricultural tasks. Adebayo (2009)) in a study titled "Constraints to Participation in Income Generating Enterprises among Youths" in Birnin Gwari LGA, Kaduna State, Nigeria revealed that most of the youths are expected to be energetic, hence their commitment to participation in the development of agriculture and other income generating activities.

Also, majority (60.8%) of the respondents were males while 39.2% were females. This implies that males participated in agricultural enterprises more than females in the study area. This may be due to the drudgery associated with agricultural enterprises. Table 1 also shows that 31.6%, 30.0% and 24.2% of the respondents had tertiary, secondary and primary education respectively while only 14.2% of them had no formal education. This implies that most (85.8%) of the respondents had some form of formal education. Formal education can influence decision making concerning agricultural enterprises. This finding is in agreement with that of Amaza *et al.,* (2009) who reported that a greater percentage of the youth in Southern Borno State, Nigeria who participate in agriculture (93.64%) had some form of formal educations. They opined that formal education would help youth to use the production and technical information efficiently and to also learn new things within a short period of time. On their contact with Extension, the results in Table 1 show that majority (75.0%) of the respondents did not have access to extension service while only 25.0% had contact with extension agents. This implies that extension contact which is supposed to be one of the main sources of agricultural information/ technologies was insufficient in the study area. This may negatively affect their level of participation in agricultural enterprises. This finding is similar to that of Bello *et al.,* (2014) who reported that only 35.0% of the youth involved in rice production in Lafia LGA of Nasarawa State had access to extension services. Results in Table 1 also show that majority (75.0%) of the respondents did not have access to credit while only 25.0% were able to obtain loan. This shows that the respondents were incapacitated by inadequate finance to invest in agricultural enterprises. This would result in low scale of production, low output and also low income and therefore perpetual poverty. Majority (60.8%) of the respondents had 1-10 years of experience in agricultural enterprises. The mean year of farming experience of the respondents was 11 years. This implies that most respondents had some level of experience in agricultural enterprises in the study area. According to Salau *et al.,* (2013), experience is very important because it enhances managerial capability of an entrepreneur. The longer the years of farming experience the higher the farm management skills. Majority (65.8%) of respondents had annual income level of between N1,000 - N300,000:00 followed by 18.4% who earned between N301,000:00-N600,000:00 annually while 15.8% of respondents earned above N600,000:00. The mean annual income of the respondents was N402, 250.0 This implies that youths in the study area earned low income. Agbamu (2006) noted that it is not always easy to determine the level of income of Nigerian farmers because some of them do not keep records while others are skeptical about disclosing their income.

Table 1: Socio-economic characteristics of the respondents (n=120)

Variable	Frequency	Percentage (%)
Age (years)		
1-20	7	5.8
21-40	113	94.2
Sex		
Male	73	60.8
Female	47	39.2
Education		
Non-formal education	17	14.2
Primary education	29	24.2
Secondary school education	36	30.0
Tertiary education	38	31.6
Extension Contact		
Had access to extension contact	29	25.0
Had no extension contact	91	75.0
Access to Credit		
Yes	30	25.0
No	90	75.0
Enterprise experience (in years)		
1-10	73	60.8
11-20	42	35.0
Above 20	5	4.2
Farm Size (in ha)		
1-10	114	95.0
11-20	5	4.2
Above 20	1	0.8
Annual income (in naira)		
1,000-300,000	99	82.5
301,000-600,000	13	10.8
Above 600,000	8	6.7
Total	**120**	**100**

Source: field survey 2018

Types of Agricultural Enterprises

The results in Table 2 show the distribution of respondents based on types of enterprises undertaken. Majority (67.5%) were into crop production, 64.2% in livestock production and 49.2% were into agricultural produce marketing. This implies that youths in the area were involved in various agricultural enterprises as a source of livelihood.

Table: 2. Types of Agricultural Enterprises

Types of Agricultural Enterprises	Percentage (%)	Ranking
Crop production	67.5	1st
Livestock production	64.2	2nd
Agric produce marketing	49.2	3rd
Agro processing	14.2	4th
Horticultural (seedlings)production	3.3	5th
Fish farming	1.7	6th
Agric inputs marketing	0.8	7th

Source: field survey 2018
Multiple responses

Constraints to Youth Participation in Agricultural Enterprises

Results in Table 3 show the constraints facing youths' participation in agricultural enterprises in the study area. These include inadequate capital (86.7%); poor access to credit (70.0%) and high cost of farm inputs (65.8%) among others. This implies that youth were faced with several constraints that reduce their participation in agricultural enterprises. Thomas, (2014) in his study "Determinants of Participation in Youth-in-Agriculture Programme" in Ondo State, Nigeria also identified the major constraints facing agricultural enterprises to include inadequate capital;

inadequate skilled personnel, poor infrastructure such as transport, processing, storage and marketing facilities among others.

Table: 3. Constraints to Youth Participation in Agricultural Enterprises

Constraints	Percentage (%)	Ranking
Inadequate capital to set up enterprise(s)	86.7	1st
Inadequate credit facilities	70.0	2nd
High cost of farm inputs such as fertilizer, pesticides, seeds, etc	65.8	3rd
Lack of good physical infrastructure for easy transportation of the farm produce to the store.	58.8	4th
Inadequate technical skills	52.2	5th
Unfavourable government policies	50.0	6th

Source; field survey 2018
Multiple responses

Conclusion

The study has revealed that youth in the central agricultural zone of Nasarawa state were involved in three major agricultural enterprises namely crop production, livestock production and agricultural produce marketing. However, they faced some major constraints such as inadequate capital, poor access to credit and high cost of farm inputs among others. It was recommended that governments at all levels should provide more incentives such as credit facilities, subsidized farm inputs and capacity training for youth in agriculture to enhance higher productivity and profit.

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Gender Differentials in Decision-Making among Ginger Farmers for Sustainable Rural Households in Abia and Imo States Nigeria

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Abstract
This study investigated gender differentials of decision-making on ginger production for sustainable rural households in Abia and Imo States, Nigeria. Multi-stage sampling technique was used to select 60 ginger farmers for the study. Data was collected by means of interview schedule with focus group discussion and analysis done using frequency tables and Pearson chi-square. The result of Pearson chi-square revealed that Area of ginger cultivated by male and female farmer is significantly different at 10% level of probability. Also, decision on ginger production, use of labour, other input and participation in farm operation were significantly different at 1% level of probability each in favour of male farmers. This implies that men take major decision in all the activities involved in ginger production. Major constraints found to militate against ginger production in the study area are Lack of funds and unavailability of planting materials. Based on the study findings, it is recommended that farmers especially female ones should be empowered financially (giving them more access to resources and farm inputs) and awareness of men on gender issues should be intensified and given utmost priority in the study area. Also, enforcement of laws and regulations at the local level to stop cattle from damaging ginger crops.
Keywords: Gender, Decision-making and Ginger production

Introduction
Gender is a sociological concept that tends to differentiate the characteristics, qualities, roles and activities of men and women. The roles are socially defined and are based on traditions, culture and beliefs of a particular group of people at a time in a particular place (Ngome, 2003). Gender differentiation in decision making among farmers families is a sex-role differential which explains the differences in the role of men and women. Gender has been demonstrated to permeate the different aspect of production and life in the agricultural settings of various countries and cultures. Traditionally, men are known to be heads of households in African setting, but certain studies of social and economic trends suggest significant increase in the number of households headed or principally maintained by women in rural areas of many developing countries (Folbre,1991). Male heads of households controls farm resources and labour, it seems logical that women engage in a formal sector work primarily because they need the additional income to sustain themselves and their families. Women are frequently neglected in economic, trade and development policies and planning because of socio-historical patterns in regard to gender based division of labour. The role of women is generally associated with non-economic and unpaid work, most of which take place within the so-called reproductive economy. However, it is the reproductive economy that supplies labour and social capital to the economy and transmits social and cultural values to communities even when such a contribution is not registered in systems of national accounts. Men and women in rural areas and throughout the world have a role to play in ginger production since both contribute to the efficiency and effectiveness of the farming. Ginger (*Zingiber officinale*) is a rhizome, which consist of numerous short finger-like structures or branches born horizontally near the surface of the soil. It belongs to the family of *Zingiberaceae*. It is a slender perennial plant with thick and branched underground stem (rhizome). Two commercial varieties are commonly cultivated in Nigeria. The yellow ginger variety locally called "TafinGiwa" is stout with short internodes. The black ginger

variety locally called "YatsunBiri" has a dull-grey colour rhizome. The yellow variety is more popular than the black variety apparently due to its high yielding capacity and pungency. Ginger is a spice and root crop grown as cash crop in Nigeria, mostly grown in the southern part of Kaduna State (Northern Nigeria) for export. Ginger is not only an income earner for individual farmers, it is as well a foreign exchange earner for the country, and the dried products are the major forms of which ginger is traded internationally. It also has various uses, which ranges from been used as spices in soups, confectionaries, zingiberone (anti-helmintic) from *Zingiber officinale*, *oloresine* are among the extracts used for medicinal purposes (Mallam, 2011). Fresh ginger is consumed as vegetable. Ginger powder is used in making ginger beer, wine, and baked foods. The essential oil obtained from ginger is used in the food and perfume industries. Ginger offers a substantial protection from stroke and heart attack because of its ability to prevent blood clotting and a multifaceted herb, crucial in the battle against cardiovascular diseases such as bowels and kidney diseases, respiratory system, colds and flu, headache, pains, stomach upsets and as well helps to clear sore throats. This study focused on gender differentials of decision-making on ginger producing households which according to Koppelman and French (Ijere,1992) is the level at which all farm decisions are made. Decisions have to be made when persons having limited resources have alternative course of action and therefore must make some choice (Oji, 2002).

Farmers make decisions on a number of pre-harvest and postharvest activities such as what to produce, input use, harvest and post-harvest issues, which according to William (2003) affect production, processing, distribution, prices and costs. Farming decisions are made to maximize farm objectives subject to available material and human resources. In all farm operations planning, farm decision is always at the core of farm management functions (Akibu, 2002). Women are key players in the Nigerian agricultural sector, especially within rural communities. They contribute between 40 and 65% of all hours spent in agricultural production and processing and also undertake 60 to 90% of the rural agricultural product marketing, thus providing more than two thirds of the workforce in agriculture (Sabo, 2006). However, despite the significant role played by women in agricultural production, processing and marketing in Nigeria (Barasa, 2006; Nweke & Enete, 1999) available literature show that men have continued to dominate farm decision making, even in areas where women are the largest providers of farm labour (Amaechina, 2002; Anyanwu & Agu,1996 & Mosha ,1992). Women have more or less been relegated to playing second fiddle in farm decision making. This could be counterproductive, because, there is bound to be conflict when women, as key players, carry out these farm tasks without being part of the decision process, especially when the decisions fail to recognize their other peculiar household responsibilities. Previous efforts at estimating women's role in agriculture have tended to concentrate on evaluating their labour contributions (Barasa., 2006; Enete., Nweke. & Tollens ,2002; FAO,1995). There has been little or no farm-level information regarding their role in farm decision-making, particularly in male dominated cash crop environment like ginger households in Abia and Imo states, Nigeria, this necessitated the study.

Methodology

Multi stage sampling techniques was used for the study. In the first stage, one local government area each was randomly selected from two ginger producing states, Abia and Imo states namely Isialangwa south from Abia and Ngor-okpala from Imo state. In the second stage, four communities from Abia state that are noted for ginger production were purposively selected they are isieketa, Uvokwu, Ngwobi and Umuojima efere. Two communities in Imo namely Nnorie and Logara were also purposively selected. Four communities were purposively selected in Abia state unlike two in Imo state because of the predominance of more ginger farmers in Abia state. In the third stage, 10 ginger farmers were randomly selected from the six communities, of the two states, making a total of sixty ginger farmers selected as respondents. Data were collected with the use of structured interview schedule and focus group discussion. Analysis of data was done using descriptive and inferential statistics.

Results and Discussion

Table 1 showed Pearson chi-square test of Involvement of male and female respondents in ginger production in the study area. The result revealed that Area of ginger cultivated by male and female farmer is significantly different at 10% level of probability which implies that there is significant difference between men involvement in ginger production than women. Men involvement in ginger farming is higher than female. Also decision on ginger production, use of labour and other input and participation in farm operation were significantly different at 1% level of probability each in favour of male farmers. This infers also that there is significant difference between men involvement in ginger production than women. This finding may be explained with the reasoning, that probably the cost of rhizome seed and other inputs for ginger production per hectare is higher than other crops cultivated in the areas, thereby making it difficult for women to acquire sufficient quantities for production due to lack of funding. Table 2 highlighted different constraints to ginger production in the study area; The result indicated that both male and female ginger farmers reported same problems such as lack of funds (26% for male and 9% for female farmers) which is the major constraint hindering ginger production in the study area. This is so because fund is important to enhance access to inputs and marketing costs like storage and transportation. It agrees with findings of Nasiru, (2010) who noted that availability of funds could have prospect in improving the productivity of farmers and contributing to uplifting the livelihoods of disadvantaged rural farming communities. This was followed by unavailability of planting materials which constituted (11 and 11%) for both gender groups while unavailability of agricultural credit and lack of extension personnel were not major constraint to ginger production in the study area. The result of the focus group discussion discovered that some farmers also see ginger as a weed in their farm, in that case, they do not maintain it well, the farmers itemized some recommendations for improvement of ginger in the study area to include provision of adequate fund by government to procure the planting materials and farm inputs such as fertilizer and herbicides and to stop cattle from damaging their ginger farms.

Table 1: Pearson chi-square test of Involvement of male and female respondents in ginger production in Abia and Imo States

Variables	Involvement		Total Response	Pearson Chi-square
	Male	Female		
Farming experience (yrs).				
1-10 yrs.	19	8	27	
11-20 yrs.	19	11	30	
> 20 yrs.	1	2	3	
Total	39	21	60	7.319 ns
Area of ginger cultivated (ha)				
< 1 ha	7	9	16	
1-2 ha	31	11	42	
>5 ha	1	1	2	
Total	39	21	60	4.806 *
Decision on ginger production				
Husband	35	3	38	
Wife	0	18	18	
others	4	0	4	
Total	39	21	60	47.854 ***
Decision on use of inputs for ginger production				
Husband	35	3	38	
Wife	0	18	18	
Others	4	0	4	
Total	39	21	60	47.854***
Decision on use of labour for Ginger production				
Husband	34	2	36	
Wife	1	19	20	
Others	4	0	4	
Total	38	14	52	47.521 ***
Participation in farm Operation				
Land preparation	25	3	28	
Bed making	13	0	13	
Planting	1	16	17	
Mulching	0	1	1	
Weeding	0	1	1	
Total	39	21	60	44.089***

Ns = Not significant * significant @ 10 percent probability level, ***significant @ 1percent probability level

Table 2: Distribution of respondents on constraints to ginger production in the study area

Constraints	Male	Female	Total
Unavailability of planting materials	11	11	22
Lack of Funds	26	9	35
Unavailability of agric credit	2	0	2
Lack of Extension Personnel	0	1	1
Total	**39**	**21`**	**60**

Conclusion

It is clearly indicative that there is gender inequity in decision-making among the ginger farming households surveyed. The findings of this study revealed that women are still not actively being involved in decision making as their male counterparts and this however has some effects on ginger production in the study area. The reason(s) for inactive participation of women could be linked to the gender inequity in resource allocation and asset acquisition. Lack of funds and unavailability of planting materials are found to be major constraints facing ginger production, it was therefore recommended that farmers should be empowered especially female ones financially (giving them more access to resources and farm inputs) and awareness of men on gender issues should be intensified and given utmost priority in the study area.

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Assessment of Youth Empowerment Programmes and its Implication towards Community Development In Ahoada East Local Government Area Of Rivers State, Nigeria

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Abstract
This study assessed youth empowerment programmes and its implication towards community development in Ahoada East Local Government Area, Rivers State, Nigeria. Simple random sampling was used to select 60 youths from Ahoada central, Ula-upata, and Ogbele communities in the Local Government Area. Data were collected using validated structured questionnaire and interview schedule. Descriptive statistic including percentage and mean score were used for analysis. Majority 60.0% of the youths were male, 65.0% of them were singles, 93.0% were literates whereas 43.3% of them were farmers. The following youths empowerment programmes were perceived by youths as being very effective: Need for Power (N-power) ($\bar{x} = 3.25$), Igbu upata football competition ($\bar{x}$ =2.98), Niger Delta Petroleum Resources bursary ($\bar{x}$ =2.90). The youths had high level participation in NDDC skill acquisition ($\bar{x}$ = 2.76), youth initiative for sustainable agriculture ($\bar{x}$ = 2.71). The major challenges in youth empowerment programmes were: poor political will power($\bar{x}$ = 2.98), Inadequate infrastructural facilities ($\bar{x}$ =2.85). Based on the findings of this study, it was recommended that government should empower youths with effective programmes for sustainable livelihood in their communities.
Keywords: Youth, empowerment programmes and community development

Introduction
Empowerment programme is an initiative instituted to be of positive action oriented to enhance community development. Community programmes over the years have been viewed as a means of reaching out to individuals including youth in any given locality. Since youths are active, energetic and mostly in the majority; through empowerment programmes, they could identify their areas of interest, skills potentials and transform them into desired actions for potential developed. The youths through skilled empowerment programmes such as agricultural agri-business, fish farming, and poultry keeping self-sustainable. They will become employer of labour, foot their bills, manage their homes and become responsible members of their community. In agricultural production, there are lots of natural resources when put into use among the youths could make them very productive (AGRA, 2017). Youth programs when planned to their needs, potentially could counter youth risky behaviours (Ajani, Mgbenka, Onah, 2015). This can be achieved through constructive opportunities, teaching the fundamental principles and skills needed to help young people become responsible, empowered, and productive citizens. Developing countries have been faced with rise in population, food insecurity, unemployment poverty and hunger (Ajani, 2015). These have resulted to less focus on matters concerning youth empowerment and livelihood. In some areas where these programmes were established, much attention has not been paid to the benefits of the youths. Nonetheless, therefore there is need for empowerment programmes to be established based on the needs and concerns of the individuals it is meant to serve. This study aimed to assess youth empowerment programmes and implications for community development in Ahoada East Local Government Area (LGA) of Rivers State, Nigeria.

Methodology

This study adopted Ahoada East one of the 23 Local Government Area of Rivers as the place of interest in this study. The state is located in the southern region of Nigeria between latitude 40◦ 22′E and 7◦ 55′ (NPC, 2006). The population of the study comprised all youth in the various communities in the LGA. In selection of the sample, simple random sampling was used in selecting 3 (Ahoada central, Ula-upata, and Ogbele) communities in the Local Government Area. Twenty (20) youths were randomly selected from each of the selected communities; this gave a total of 60 youths (i.e. 20x3=60). Interview and structured questionnaire were used to obtain data from respondents. Descriptive statistics such as frequency, mean, and percentage were used for data analysis.

Results and Discussion

Socio-economic analysis of the respondents

Table 1 shows that majority (60%) of the respondents were males. This suggests that males are mostly targeted than females in youth empowerment programmes due to their strength and energy. About (41.7%) of the youths are young and below the age of 30. This reveals their interest, independence and commitment in community development. Marital status reveals that greater proportion (65.0%) of the respondents were single. This implies that the respondents need to be empowered to be self-sustainable. Majority (51.7%) of the respondents attained secondary education, whereas 6.7% of them had no formal education. Results show that (53.3%) of the respondents household range was 6-10, while 6.7% had 16 and above. This implies that most of the respondents are from large families who depend on each other on feeding and shelter. About (43.3%) of the respondents were engaged in farming, while 11.7% of them were civil servants. This suggests that the youths depend on agriculture for their empowerment.

Socio-economic analysis of the respondents

Variables	Frequency	Percentage (%)	Mean ($\overline{X}$)
Gender			
Male	36	60	
Female	24	40	
Age			
18 – 21	3	5.0	
22 – 25	11	18.3	27.20
26 – 29	25	41.7	
30 – above	21	35.0	
Marital status			
Single	39	65.0	
Married	13	21.7	
Widow/Widower	3	5.0	
Educational Level			
Non-formal	4	6.7	
Primary	9	15.0	
Secondary	31	51.7	
Tertiary	6	26.6	
Household size			
1-5	18	30.0	
6-10	32	53.3	8 persons
11-15	6	10.0	
16 and above	4	6.7	
Occupation			
Civil Servant	7	11.7	
Trader	18	30.0	
Farmers	26	43.3	
Contract Workers	9	15.0	

Source: Field Survey Data, 2017

Effectiveness of youth empowerment programme in Ahoada East LGA

Table 2 shows that nine (9) out of the 15 youth empowerment programmes were perceived by the respondents as functioning very effective, while N-power ($\bar{x}$ = 3.25) had the highest mean. This suggests that N-power contribute very effectively in empowerment programmes.

Table 2: Effectiveness of youth empowerment programme as perceived by the respondents

Variables	**Mean$(\overline{X})$**
Youth initiative for sustainable agriculture	2.80
N-power	3.25
NDDC skill acquisition	2.56
Igbuupata football competition	2.98
Ekpeye wrestling competition	2.41
Young Entrepreneurship Nigeria	2.33
Youth Empowerment with Innovation in Nigeria	2.78
Graduate Internship Scheme	2.81
Total M.sc-PGD programme	2.66

Source: Field Survey Data, 2017
Mean score ≥ 2.50

Level of Youth participation in employment programmes in Ahoada East LGA

Entries in Table 3 shows the respondents always participated in four programmes out of 7. The respondents had high level of participation in programmes such as youth initiative for sustainable agriculture ($\bar{x} = 2.71$), NDDC skill acquisition ($\bar{x} = 2.76$), Igbuupata football competition ($\bar{x} = 2.50$) and Ekpeye wrestling competition ($\bar{x} = 2.55$).

Table 3: level of participation in youth empowerment programmes

Programmes	Mean$(\overline{X})$
Youth initiative for sustainable agriculture	2.71
N-power	1.68
NDDC skill acquisition	2.76
Igbuupata football competition	2.50
Ekpeye wrestling competition	2.55
Young Entrepreneurship Nigeria	1.45
Graduate Internship Scheme	1.53

Source: Field Survey Data, 2017 Mean sore ≥ 2.50

Challenges of youth empowerment programmes in Ahoada East LGA

Entries in Table 4 reveal that 10 items out of 12 were perceived by the respondents as challenges of youth empowerment programme. These include poor political will power ($\bar{x}$ = 2.98) which was highly perceived by the respondents as constraints in youth empowerment programmes. This implies that inadequate physical structures and facilities might limit the impact of development efforts.

Table 4: Challenges of youth empowerment programmes as perceived by the respondents

Youth Empowerment Programmes	Mean $(\overline{X})$
Favoritism (" man know man")	2.70
Corruption	2.75
Access to loan	1.55
Poor publicity of the empowerment programme	2.63
Lack of start-up capital	2.81
Poor road networks	1.80
Access to internet facilities	2.55
Declining growth of the economy	2.80
Poor political will-power	2.98
Poor monitoring of youth programme	2.60
Lack of funds	2.73
Inadequate infrastructural facilities	2.85

Source: Field Survey Data, 2017; Mean score ≥ 2.50

Conclusion

It is evident that the youths are involved in sustainable agriculture programmes which were community based initiatives such Niger Delta Development Community skill acquisition. The N-power was considered very effective as youth empowerment programmes. Social infrastructure is a prerequisite to ensure for successful youth empowerment programme, though poor political will-power and inadequate infrastructural facilities were major constraints in youth empowerment programmes. There is need to adopt effective strategy to ensure full participation of youths by concerned actors. Challenges such as poor programme framework, inadequate, funding, nepotism and corruption should urgently be addressed by the programme donors and sponsors.

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Farmers Indigenous Knowledge Practices for Cassava Conservation in Nigeria

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Abstract
Farmers indigeonus knowledge practices for conserving cassava in South Eastern Nigeria was assayed. A sample size of 480 respondents were randomly selected from Abia, Akwa Ibom and Ebonyi States. Structured interview schedule was used to elicit information from the respondents, which were analysed using descriptive statistics. The result showed that 61.5% of the respondents were males, with mean age of 26 years. Based on local conservation traits, 56.2% of the respondents conserve varieties by maintaining favoured varieties. As regards roles played by each group in conserving the materials, 47.0% of the respondents had no idea of who was actually responsible for this amongst the men, women and youths. Based on the findings, farmers' prefrred method(s) of conservation should be improved upon, given thoughts to complementary methods for maximum utilization of the resource materials.
Keywords: Cassava, Indigenous knowledge, and Conservation

Introduction
Cassava is a staple food for most Nigerians and is known as the energy giving food par excellence, given that it could provide most of the body's daily energy requirement. Cassava (*Manihot esculenta* Crantz*)* is important not just as a subsistence or food security crop, but also as a main source of cash income for producing households (Bainbridge *et al,* 1997). Cassava has the ability to adapt to marginal soils, including drought stress and produces reasonably well comparatively to other crops in marginal environments with low rainfall (El-Sharkawy, 2005), climatic factors resulting to drought-high temperature, high wind and low relative humidity. Cassava is a perennial crop and has bulking duration which ranges from 8 weeks after planting to 24 months after planting, which makes it a suitable crop for drought prone regions of the world. Plant breeders select genotypes/varieties with genetic potentials for high vigour, resistant to pests and diseases, good root size, number of roots, high dry matter content *et cetera*. In addition, cassava with high protein content, beta carotene content, starch, dry matter content, delayed shelf life of roots, are some traits farmers and end-users are looking for in Nigeria (Njoku *et al,* 2015). Agricultural practices are inextricably woven into broader traditions, customs and wisdom among humankinds enterprise. There is need for scholars to sit back and re-assess the evolution of agricultural practices in order to align them with current environmental realities and the quest for agricultural sustainability. Indigenous knowledge (traditional wisdom) is a key to sustainable rural development in Nigeria. In 1993, the United Nations declared that year as a year of indigenous people to attest to the importance of traditional technological endowment in sustainable rural development. Warren (1991) and Flavier (1995) defined indigenous knowledge as "the local knowledge that is unique to a given culture or society." The basic component of any country's knowledge system is its indigenous knowledge. It encompasses the skills, experience and insights of people applied to maintain or improve their livelihood. Indigenous knowledge is developed and adapted continuously to gradually changing environments and passed down from generation to generation and closely interwoven with peoples cultural values. Cassava genetic resources can be conserved either *in situ* or *ex situ*, or a combination of the different methods used in a complementary way. Disadvantages in one method used (for example, risks of diseases

and loss through other natural factors in the field gene bank) are compensated for by the benefits of another, example, the relatives security of *in vitro* conservation. Farmers have a lot of underutilized information as a result of long experience with cassava cultivation. These include characteristics of adaptation, resistance, morphology quality or a number of traits that may not become apparent to a researcher, even after standardized evaluations. Cassava which is widespread in the area of study has a variety of uses which emphasizes the need for conservation of crops.Genetic erosion is anticipated due to the replacement of landraces by improved cultivars produced by research (Allem and Hahn, 1991). Farmers indigenous conservation practices in this study are of essence. This paper reports the results of a survey conducted to document farmers` indigenous practices for cassava conservation in S.E. Nigeria.

Methodology

The study area was south-east agro-ecological zone of Nigeria with Abia, Akwa-Ibom and Ebonyi States purposively chosen.These States represent each from the mangrove swamp(Akwa-Ibom) rainforest (Abia) and the derived savannah(Ebonyi), where cassava is a major crop of the farming system of the people.-A sample size of 480 respondents were randomly selected from the study area.Two agricultural zones were randomly selected from each of the states in the first stage-Umuahia and Ohafia zones from Abia, Eket and Oron in Akwa-Ibom and Ebonyi South (Afikpo) and Ebonyi North (Abakaliki) from Ebonyi. Two blocks were randomly selected in each zone, while four circles were randomly selected from each block. Finally, ten cassava farmers were randomly selected from each circle giving a sample size of 160 respondants per state. Listing of correspondants was through the guidance of Extension Agents in-charge of the selected circles. Data were collected through the use of structural questionaires. Data collected were analysed by the use of frequencies, percentages and means.

Results and Disscussion

The distribution of respondents according to sex, age, farming experience and educational attainment are as indicated in Table one. About 61.5% of the respondents were males. The dominant participation of males maybe attributted to their access to land, information and other production resources more than their female counterpart. The mean age of the respondents was 26years with 38.5% in the age range of 41-50years, while 51-60 constituted 28.8%. The ages of farmers are important in determining participation in innovation (Nwaru, 2004). The age bracket of 41-50years indicates that majority of the respondents were middle aged farmers who were still active and more likely to adopt innovation better and faster than their elderly counterparts who may be conservative to try new techniques (Gul, Unal, 2008). The farming experience was 20.6% for 26-30years, 20.0% for $\geq$ 31years. The mean farming experience was 13.6years indicating that a good number of new people are embracing agriculture. farmers experience can generate or erode confidence. Educational attainment from the table shows that 32.0% of the respondents had primary school education, while 12.7% had none. Differences in educational attainment definitely will affect farmers' perception and efficiency in technology use. Educated farmers are more receptive to change than others in seeking information as particularly such information as they can obtain from extension. Table 2 shows the cassava verities planted by the farmers. About 76.0% of the respondent grew both improved varieties and landraces, while 20.5% grew improved varieties only. Certain cassava cultivars are predominantly cultivated in specific areas and farmers' preferences are based on certain characteristics. These characteristics affect farmers' perception and the dynamics of adoption of cassava varieties. Result on Table 3 shows distribution of respondents according to local conservation traits. It shows that 56.2% of the respondents conserved cassava varieties by maintaining favoured varieties while 14.6% and 12.3% were conserved by indigenous production and names respectively. Farmers preferred method(s) of conservation should be improved upon and encouraged viz-a-viz the improved conservation methods. An understanding of farmers' indigenous knowledge and technology is not that easy as indigenous knowledge may be as numerous as sampled farmers. Table 4 shows the roles played by each group in protecting cassava genetics resources. The table shows that 47.0% of the respondents had no idea of who was responsible for protecting cassava genetics resources. However, 25.6% were of the opinion that women were more involved than the men and the youths. Howard (2003) shows how gender relations inform genetic resources management and conservation, and in several cases, women predominate particularly in the management of plant genetic resources.

Conclusion

Farmers' indigenous knowledge practice for conserving cassava in the zone was assayed given the agricultural practices and the people's traditions and customs. Cassava which has diverse uses in the area of study needs to be adequately conserved for maximum utilization of the resource materials. Complementary conservation practice is key to the management of the genetic materials. Farmers and research should complement each other's effort for a sustainable system, adopting on-farm adaptive research and other participatory approaches.

Table 1: Distribution of respondents according to sex, age, educational attainment and farming experience

Variables	Frequency	Percentage
Sex		
Male	295	61.5
Female	185	38.5
Total	480	100.0
Age (Years)		
<30	18	3.8
31 – 40	69	14.3
41 – 50	185	38.5
51 – 60	138	28.8
>60	70	14.6
Total	480	100.0
Mean	26.0	
Farming Experience (Years)		
<10	96	20.0
11 – 15	77	16.0
16 – 20	75	15.6
21 – 25	40	8.4
26 – 30	99	20.6
>31	93	19.4
Total	480	100
Mean	13.6	
Educational Attainment		
No formal education	61	12.7
Primary school education	154	32.0
Secondary school education	119	24.8
OND	35	7.3
NCE	41	8.5
HND	31	6.5
B.SC	31	6.5
M.SC	8	1.7
Total	480	100

Source: Field Survey Data 2014

Table 2: Distribution of respondent according to cassava varieties planted

Variables	Frequency	Percentage
Landraces	17	3.5
Improved Variety	98	20.5
Both Improved and Landraces	365	76.0
Total	480	100.0

Source: Field Survey Data 2014

Table 3: Distribution of respondents according to local conservation traits

Variables	Frequency	Percentage
How cassava varieties are maintained		
Myths	5	1.0
Songs	3	0.6
Names	59	12.3
Indigenous production	70	14.6
Collection	35	7.3
Trading	1	0.2
Stealing	3	0.6
Maintaining favored Varieties	270	56.2
Purging the less desirable	33	7.0
Others	1	0.2
Total	480	100

Source: Field Survey Data 2014

Table 4 distribution of respondents according to key players in protecting cassava genetic resources

Variable	Frequency	Percentage
Men	**6**	**1.3**
Women	**123**	**25.6**
Youths	**19**	**22.1**
No Idea	**226**	**47.0**
Total	**480**	**100.0**

Source: Field Survey Data 2014

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Effect of Adoption of National Special Programme on Food Security (NSPFS) Extension Recommendations on Cassava Production in South-East, Nigeria

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Abstract
The study examined the effect of adoption of National Special Programme on Food Security (NSPFS) extension recommendations on cassava production in South-East, Nigeria. Specifically, it ascertained the level of adoption of NSPFS extension recommendations on cassava production by farmers, and determined the effect of National Special Programme on Food Security on cassava production in the study area. Multi-stage random sampling technique was utilized in selecting three hundred and sixty respondents (comprised 180 NSPFS participants and 180 non-participants) used for the study. Data were obtained with the aid of structured interview schedule and Focus Group Discussion, and analyzed using descriptive and inferential statistics, such as means and Z-test. From the results, grand mean score of 2.31 shows moderate level of adoption of NSPFS extension recommendations on cassava production by farmers in South-East, Nigeria. The findings showed significant difference between cassava yield of participants and non-participants. The National Special Programme on Food Security increased cassava production in South-East, Nigeria. The null hypothesis that the National Special Programme on Food security has not significantly increased yield of cassava was, therefore, rejected, while the alternative hypothesis was accepted. The study therefore recommended that farmers should be sensitized and educated by Government on the importance of adoption of extension recommendations for increased food production, income and enhanced standard of living.
Keywords: Adoption, extension recommendations and cassava production

Introduction
The vast majority of the world's poor lives in rural areas and is engaged in agriculture, therefore activities designed to address the vulnerability of these rural poor are often geared towards improving agricultural practices as a means of increasing productivity, efficiency and ultimately, income (Parvan, 2011). Governments, NGOs, aid agencies and extension workers have long known that the success of any programme or project depends, in part, on whether farmers adopt the offered technologies and, if they do, whether those farmers adopt the technologies in an ideal combination and for the prescribed length of time needed to produce designed results. Adoption refers to a full-scale integration of recommended practices or innovation into the on-going farm operation (Eze, 2005). According to Tokula (2008) adoption of extension recommendation is described as one important process through which systematic social change take place in rural areas. He further observed that at this stage, the individual decides to employ the new practice as not only useful but full impression of satisfaction on the part of the farmer. Adoption does not imply indefinite use of innovation, but the farmer uses the new practice until something else comes up to make him dissatisfied with the innovation. This means that adoption process is that stage when the farmer accepts and integrates the new practice in his farming enterprise and exhibits his sustained decision to practice the technology until otherwise discouraged by new situation. The World Food Summit in a meeting in Rome in 1999 estimated that 790 million people in the developing world do not have enough food to eat (Alamu *et al*., 2005). As a follow up to the summit, Nigeria, one of the 82 Low-Income Food Deficit Countries (LIFDC) requested for assistance under the FAO's National Special Food Security Programme (NSFSP). The National

Special Programme on Food Security (NSPFS) was implemented in a stepwise fashion in Nigeria, starting with pilot activities initially at a few locations, which were progressively scaled up with the aim of gaining pilot experience in all major agro-ecological zones of the country. The pilot phase focused on household and community level food security and livelihood issues, while the first phase tackled these issues at national level so as to open the way for more scaling-up. The first phase was up-scaled into a five-year, nation-wide Special Programme for Food Security (SPFS) between 2002 and 2006, covering the 36 states of the country with a total programme cost of USD 45.2 million exclusively funded by the Federal Government of Nigeria. The nationwide SPFS programme was completed in June 2006 and has already demonstrated very positive impact (Dauda and Ajayi, 2009). Realizing the need to improve small-scale production and sustainable agriculture for food security to reduce hunger rapidly, the government expanded the programme to more sites in each of the 36 states and in Abuja, from 2007 to 2014. At this expansion phase, the programme was renamed National Special Programme on Food Security (NSPFS) in 2007. The implementation of NSPFS in Nigeria was expected to have enhanced adoption of extension recommendations by farmers and improved cassava production in South-East Nigeria, among other objectives. However, the programme with all the laudable objectives ended in 2014, but the level of adoption of its extension recommendations on cassava production is quite unknown, hence this study. Specifically, the study ascertained the level of adoption of NSPFS extension recommendations on cassava production by farmers, and determined the effect of National Special Programme on Food Security on cassava production in the study area.

Methodology

The study was conducted in South-East, Nigeria. The Zone is made up of five states, namely, Abia, Anambra, Ebonyi, Enugu and Imo States. The states in the zone share similar characteristics (NPC, 2006). The zone covers the bulk of the Igbo-speaking ethnic territory or Igboland. The area lies mainly on plains under 200m above sea level. It is bounded on the south by Akwa Ibom and Rivers States, on the east by Cross River State, on the west by River Niger and Delta State, and on the north by Benue State (Monanu, 2000). There were four States that participated in the National Special Programme on Food Security in the zone. Three states namely Ebonyi, Enugu and Imo States were randomly selected from the four States that participated in the programme. Three agricultural zones were purposively selected from each of the selected states. This gave a total of nine agricultural zones. They were Okigwe, Orlu, Owerri in Imo State; Nsukka, Enugu, Awgu in Enugu State; Ebonyi North, Ebonyi Central and Ebonyi South in Ebonyi State. Two blocks were randomly selected from each of the selected agricultural zone; two circles were randomly selected from each of the blocks selected. Five participants of NSPFS were randomly selected from the list of participants in each of the selected circle, while five non-participants were randomly selected from the list of non-participants in the thirty-six selected circles. The lists of farmers were obtained from the respective circle extension agents. A total of Three hundred and sixty respondents were interviewed, comprised 180 NSPFS participants and 180 non-participants. Data were obtained with the aid of structured interview schedule and Focus Group Discussion, and analyzed using descriptive and inferential statistics such as means and Z-test. To determine level of adoption of NSPFS extension recommendations, farmers' responses were categorized into: Never adopted (1point), Adopted and stopped (2 points), Adopted and still using recommendations (3 points). The value assigned to the adoption levels in each technology were calculated thus: 1+2+3 = 6/3 = 2.0. Therefore, a mean score of less than 2.05 is poor/low level of adoption, mean score from 2.05 - 2.5 is moderate level of adoption, while mean score greater than 2.50 is high level of adoption. To determine effect of the NSPFS on cassava production, the null hypothesis that the National Special Programme on Food Security has not significantly increased cassava yield in South-East, Nigeria was tested at 5% level using Z-test. They participants and non-participants indicated their yield per hectare in the last cropping season from cassava production. Mean yield of cassava was computed and used to calculate the Z-test by applying this formula:

$$Z = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

Where Z = calculated value

$\overline{x_1}$ = Mean yield score of cassava for NSPFS participants
$\overline{x_2}$ = Mean yield score of cassava for non-participants
n_1 = Sample size of NSPFS participants
n_2 = Sample size of non-participants
σ_1^2 = Standard error for NSPFS participants
σ_2^2 = Standard error for non-participants

Results and Discussion

Level of Adoption of NSPFS Extension Recommendations on Cassava by Farmers

The results in Table 1 show the level of adoption of NSPFS extension recommendations for cassava production by farmers. Grand mean score of 2.31 shows that there was moderate level of adoption of NSPFS extension recommendations for cassava production by farmers in South-East, Nigeria.

Table 1: Level of Adoption of NSPFS Extension Recommendations on Cassava by Farmers

	Mean Adoption Scores			
Recommendations	**Imo**	**Enugu**	**Ebonyi**	**Mean ($\bar{x}$)**
Improved Cassava variety production	3.00	2.78	2.78	2.85**
Cassava/Maize/Egusi intercrop	2.73	2. 72	2.80	2.75**
Early planting of cassava	3.00	2.88	2.87	2.92**
Fertilizer application	2.78	2.50	2.35	2.54**
Soil fertility improvement	2.88	2.97	2.95	2.93**
Soil sampling	1.07	1.12	1.07	1.09
Processing	2.95	3.00	3.00	2.98**
Herbicides application	1.27	1.23	1.25	1.25
Book keeping	1.88	1.37	1.15	1.47
Grand mean	**2.40**	**2.29**	**2.25**	**2.31***

Source: Field Survey, 2016. **High level of adoption, *Moderate level of adoption

Although there was high level of adoption in cassava processing (2.98), soil fertility improvement (2.93), early planting of cassava (2.92), improved cassava variety production (2.85), cassava/maize/egusi intercrop (2.75) and fertilizer application (2.78), while there was low level of adoption of book keeping (1.47), herbicides application (1.25) and soil sampling (1.09) extension recommendations on cassava by farmers. It is expected that high level of adoption of extension recommendations on cassava would lead to increase in cassava production and yield in the study area. This agrees with Agbarevo and Obinne (2009) that there is significant effect of adoption of research and extension recommendations by farmers on the yield of crop.

Effect of NSPFS on Cassava Yield of Farmers

Information in Table 2 shows the effect of NSPFS programme on cassava yield of farmers in South-East, Nigeria. Results show significant difference between cassava yield of participants and non-participants in the zone. The cassava yield of NSPFS participants was 15.69 t/ha, while that of non-participants was 7.50 t/ha. The value of t-calculated is greater than the value of t-tabulated. This implies that the National Special Programme on Food Security increased cassava production in South-East, Nigeria. Hence, the Z-test rejects the null hypothesis that, the National Special Programme on Food security has not significantly increased yield of cassava in the study area, while the alternative hypothesis is accepted at 5% level. This is in agreement with Elemi *et al*. (2015) that the National Special Programme on Food Security increased yield of cassava in Cross River State, Nigeria.

Table 2: Z-test Analysis of Significance of Difference between Cassava Yield of NSPFS Participants and Non-participants

NSPFS	N	Mean	SD	t- tabulated	t-calculated
Participants	180	15.69	2.3069	1.96	1453.61**
Non-participants	180	7.50	1.7158		

Source: Field Survey, 2016. **Significance at 5%

Conclusion

There was moderate level of adoption of NSPFS extension recommendations for cassava production by farmers in South-East, Nigeria. The National Special Programme on Food Security has succeeded in increasing the cassava yield of participants. Hence, it has partly met its mandate of incremental food production, which is geared towards ensuring food security in South-East, Nigeria. The study therefore recommended that farmers should be sensitized and educated by Government on the importance of adoption of extension recommendations for increased food production, income and enhanced standard of living.

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Effect of Pesticides and Fertilizers on the Health of Farmers in Akpabuyo Local Government Area, Akwa Ibom State

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Abstract
The study assessed the effect of pesticides and fertilizers on the health of farmers in Akpabuyo Local Government Area, Akwa Ibom State, Nigeria. Specifically, the study described the socio-economic characteristics of the respondents, assessed the effect of pesticides and fertilizers on the health of farmers in the study area and identified sources and types of pesticides and fertilizers used on locally grown crops, in the study area. A sample size of 90 respondents was selected through multistage sampling procedure from crop farmers in Akpabuyo Local Government Area. Descriptive statistics such as frequency, percentage, mean scores and rank were used for data analysis. Result of the socio-economic characteristics of the respondents revealed that majority (66.67%) were males. Also, majority had farming experience of 31-40 years (38.89%). Majority (61.11%) assessed land through inheritance, they have 4-5 persons per household (44.44%), cultivated 1-2 hectares of farmland (54.44%) and earned N51,000-80,000 per annum. The results of the effect of pesticides and fertilizers on the health of farmers in the study area showed that fertilizers/pesticides during their application causes headache, dermatitis and conjunctivitis, fever and abdominal pains were ranked (1st, $\bar{X}$ = 4.25), (2nd, $\bar{X}$ = 3.76), (3rd, $\bar{X}$ = 3.50) and (4th, $\bar{X}$= 3.25) respectively, and were The result, also showed that herbicides, insecticides and bactericides ranked (1st, $\bar{X}$ = 3.90), (2nd, $\bar{X}$ = 3.85) and (3rd, $\bar{X}$ = 3.70) respectively, and were the major pesticides available for locally grown crops. The study revealed that poor handling of agro-chemicals during application impacts negatively on the health of farmers by causing headaches, dermatitis/conjunctivitis, fever and abdominal pains. The study recommend that human capacity development should be encourage through the training of farmers on efficient and safe use of agro-chemicals of crop production so as to reduce the undesirable effects/health hazards associated with use of agro-chemicals.
Key words: Effect, pesticides, fertilizers, health and Akpabuyo

Introduction
Agricultural safety and the resulting environmental and health hazards from agro-chemicals are increasingly attracting global attention. Cooper and Dobson (2007), but Effiong and Asikong (2013) and Fleisher (2006) reported that excessive use of chemical fertilizers in developing countries like Nigeria often receive less attention than the use of pesticides. Consequently, its economic and ecological effect can be dramatic and devastating, for instance, Bangladesh today faces severe loss of topsoil fertility from over application of chemical fertilizers and pesticides. Adetunji (2010). Effiong and Effiong (2015) reported that excessive use of certain agro-chemicals has been associated with contamination of ground water with nitrate rendering it unfit for human and livestock consumption by immobilizing some of the haemoglobin in the red blood cells hence reducing the ability to transport oxygen and also causing a problem in the aquatic ecosystem called Eutrophication (a process whereby green algaes develops and grow on the surface of streams, rivers and lakes due to run-off of agricultural fertilizers into them, thus diminishing oxygen content to the detriment of other organisms). It is therefore very important to assess the sources of agro-chemicals used, the perceived effects on production and the level of utilization for sustainable food productivity and security.

Methodology

The study was conducted in Akpabuyo Local Government Area of Cross River State with her headquarters at Ikot Nakanda. Akpabuyo is an agrarian area measuring approximately 28.5km^2 with an estimated population of 360,000 people (NPC, 2006) and its popularly called the "Food Basket" of Cross River State. Akpabuyo has 10 council wards and major languages spoken are Efik and English while the major ethnic groups like Efiks, the Quas and Efuts share a common cultural and ancestral heritage. Akpabuyo is a major producer of cassava, cocoyam, kolanut, coconut, palm produce as well as seafoods. The land is rich in mineral deposits at commercial quantities. A multistage sampling technique was used to select the respondents. At first stage, purposive sampling technique was used to select Akpabuyo as a block. This was because, Akpabuyo is predominantly an agrarian society. The second stage was a random selection of six cells from the block. In the third stage, 15 respondents were randomly selected from each of the selected cells. This produced a sample size of 90 respondents. Data were presented using frequency, percentage, means scores and ranking.

Results and Discussion

Results in Table 1, showed that majority of the respondents (66.67%) were males, while (33.33%) were females. About 27.78% were aged 45-54 years, 44.44% had tertiary education, 77.78% were engaged in mixed farming as a major type of occupation, 38.89% had farming experience of 31-40 years, 54.44% cultivated 1-2 hectares of farmland, 61.11% accessed land by inheritance and 33.33% earned between N51,000-N80,000 per annum. This result corroborates with the findings of Effiong and Asikong (2013) who reported that farmers in Cross River State, Nigeria, accessed land through inheritance and are engaged in mixed farming as a major type of occupation. Table 2 showed the result of sources and types of pesticides and fertilizers used for locally grown crops. The result revealed that herbicides, insecticides and bactericides ranked 1st, $\bar{X}$ = 3.90; 2nd, $\bar{X}$ = 3.85 and 3rd, $\bar{X}$ = 3.70 respectively as the major type of pesticides available for locally grown crops in the study area, while NKP, compost manure and poultry droppings ranked 1st, $\bar{X}$ = 4.11; 2nd, $\bar{X}$ = 3.88 and 3^{rd,} $\bar{\bar{X}}$ = 3.84 respectively as the major type of fertilizers available for locally grown crops. This result corroborates with the findings of Carolyn, (2013) and FAO, (2000) who asserted that application of pesticides and fertilizers increases agricultural productivity and food security hence minimizing hidden hunger phenomenon, malnutrition and malnourishment. Table 3, revealed that headache, dermatitis and fever ranked 1st, $\bar{X}$ = 4.25; 2nd, $\bar{X}$ = 3.76 and 3rd, $\bar{X}$ = 3.50 respectively as the major health hazards caused by pesticide/fertilizers usage by farmers, while allergy to agro-pesticides and fertilizers, dizziness and abdominal pain ranked 6th, $\bar{X}$ = 2.81; 5th, $\bar{X}$ = 3.00 and 4th, $\bar{X}$ = 3.45 respectively and were considered as minor health hazards of pesticide/fertilizer usage by farmers. This result is in line with the findings of Effiong and Effiong (2015) who reported that fertilizer and pesticide application has become a great threat to human health resulting in asthma, and sterility/infertility in couples and environmental degradations.

Table 1: Distribution of respondents by Socio-economic Characteristics

Variables	Frequency	Percentage
Gender		
Male	60	66.67
Female	30	33.33
Age (Years)		
15-24	10	11.11
25-34	15	16.67
35-44	20	22.22
45-54	25	27.78
≥55	20	22.22
Level of education		
No formal education	4	4.44
Primary	11	12.22
Secondary	35	38.89
Tertiary	40	44.44
Types of occupation		
Mixed farming	70	77.78
Trading	15	16.67
Civil servant	5	5.56
Farming experience		
2-10	4	4.44
11-20	6	6.67
21-30	25	27.78
31-40	35	38.89
40 and above	20	22.22
Farm size (in hectares)		
1-2	49	54.44
4-5	19	21.11
6-8	15	16.67
10 and above	7	7.78
Household size		
2-4	25	27.78
4-5	40	44.44
6-8	20	22.22
10 and above	5	5.56
Income level		
20,000-40,000	24	26.67
41,000-50,000	25	27.78
51,000-80,000	30	33.33
81,000-100,000	11	12.22
System of Land ownership		
Purchase	15	16.67
Inheritance	55	61.11
Leasehold	15	16.67
Free gift/communal	5	5.56

Source: Field survey, 2017.

Table 2: Sources and types of pesticides and fertilizers for locally grown crops

Sources of pesticide and fertilizer for locally grown crops	A (4)	O (3)	S (2)	N (1)	Mean ($\bar{x}$)	SD	Rank
Organic sources	60.0	23.5	10.6	5.9	3.95	0.38	2nd
Inorganic sources	63.0	20.0	9.4	7.6	4.05	0.35	1st
Types of pesticides available for locally grown crops							
Herbicides	40.0	35.2	22.4	2.4	3.90	0.41	1st
Fungicides	28.2	33.0	25.8	13.0	3.35	0.71	4th
Nematicides	63.6	63.5	8.2	4.7	2.10	0.75	5th
Insecticides	17.0	20.5	34.1	28.4	3.85	0.62	2nd
Rodenticides	16.5	22.1	27.3	34.1	3.70	0.5	3rd
Bactericides	8.2	10.6	64.7	16.5	1.67	0.48	7th
Botanicals (plants extracts pesticides)	7.1	12.9	44.7	35.3	1.79	0.31	6th
Types of fertilizers available for locally grown crops							
Poultry dropping	49.4	23.5	17.6	9.5	3.84	0.55	3rd
Compost manure	53.0	27.1	17.7	2.2	3.88	0.52	2nd
Green manure	57.7	20.0	18.8	3.5	2.50	0.69	4th
NPK fertilizer	51.8	18.7	16.5	13.0	4.11	0.35	1st

Keywords: Always, O = Occasionally, S = Sometimes, N = never, $\bar{X}$ = mean, SD = standard deviation
(Source: Field survey, 2017)

Table 3: Health impacts of pesticides and fertilizers on farmers

Health impacts	Very often	Often	Rare	Never	Mean ($\bar{x}$)	SD	Rank
Headache	47.9	34.3	14.4	1.4	4.25	0.38	1st
Fever	45.0	35.1	5.9	14.0	3.50	0.35	3rd
Dizziness	6.8	11.7	63.5	18.0	3.00	0.37	5th
Abdominal pain	10.6	9.6	60.7	18.5	3.25	0.45	4th
Allergy	33.5	35.9	22.9	7.7	2.81	0.72	6th
Dermatitis and conjunctivitis	50.00	30.1	17.5	2.4	3.76	0.43	2nd

(Source: Field survey, 2017).

Conclusion

Farmers in the study area were into mixed farming for about 31-40 years, farm size ranging from 1-2 hectares. Farmers in the study area perceived agrochemicals as being expensive, causes pollution, had adverse effect on human health and environments. The study therefore recommends training and retraining of farmers on efficient and safe use of agrochemicals so as to reduce the likely undesirable effect of agrochemical on famers health.

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Determinants of adoption of NRCRI's value addition cassava technology by rural farmers in Umuahia North L.G.A

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Abstract
This study was designed to examine determinants of adoption of National Root Crops Research Institute's value added cassava technology by rural farmers in Umuhia North L.G.A. A simple random sampling technique was adopted in selecting 120 rural women farmers. Well-structured questionnaire was used to elicit information from the respondents. The data generated from the survey was analyzed using descriptive statistical tools and lead square (OLS) regression model. The result of the regression analysis showed that variables such as age, household size, years of experience, education, income and membership to cooperative society influenced the adoption of value added cassava technologies. The R^2 was 0.970 meaning that 97% of the variations in adoption in the level of technologies adopted were explained by the included variables. High cost of modern processing facilities was found to be a major factor affecting adoption and it was recommended that government and donor agencies should bring intervention in this area to enhance the livelihood of the rural poor. Also more awareness should be created and credit facilities should be extended to the rural farmers to increase adoption of the cassava value-addition technologies.
Keywords: Adoption, Value addition and Cassava Technology

Introduction
Cassava (*Manihot esculenta*) is acclaimed the most important food crop both in sub-Saharan Africa and the World's at large (Anyiro et al., 2016). Statistics show that Nigeria is the World's largest producer of cassava with an annual production estimated at 39 million metric tons. (NRCRI, 2006). There was a 5 million metric tons growth in the volume of production of cassava between 2003 and 2004. Nigeria has a comparative advantage in cassava production due to her large land mass which supports its production. According to Okogbenin et. al., (2002), About 600 million people in Africa, Asia and Latin America depend majorly on cassava for subsistence probably because it can be processed into many forms. Women engagement in cassava production and processing is very phenomenal. They play major roles starting from planting, weeding, harvesting, processing and marketing. Adebayo, (2009), observed that the uses of cassava keep increasing by the day, for instance it can now be processed into chips, biscuits, alcohol to mention but a few. It is equally an essential raw material to many industries that produce livestock feed, soft drinks, confectionaries etc. Despite the status of cassava as a major staple in the food economy of Nigeria, farmers record huge losses postharvest due to the perishable nature of cassava (Aniedu et al., 2012). This also reduces the shelf life of the crop. Due this development, several technologies aimed at processing and value addition to cassava have been developed and disseminated by research institutions and extension agents (Anyiro, 2016; Nwakor et al., 2011). According to Rogers (2005), adoption is the final stages the innovation diffusion model. It takes place only when the farmers consider the innovation superior to the previous practice or input. According to literature, certain factors such as socioeconomic, demographic and institutional factors influence adoption of value added technologies (). This study therefore seeks to describe the socio-economic characteristics of the respondents and to determine the socioeconomic, demographic and institutional factors that influence the level of adoption of the Cassava value addition technology by the respondents. Finally, it seeks to identify

the constraints to the adoption of the Cassava value addition technology by the respondents in the study area.

Methodology

This study was carried in Umuahia North Local Government Area of Abia State. A multistage sampling technique was employed to select 3 rural communities out of the 35n communities that are aware of the cassava value addition technologies. Secondly, 5 villages were selected from each of the three communities. Finally 8 rural women farmers were randomly selected from the list of women trained by NRCRI, Umudike on value addition to cassava in each of villages selected. This gave a total of 120 respondents in all. Using structured questionnaires, relevant data on determinants of the rural women farmers' adoption of cassava value added technologies were collected from the respondents. Descriptive statistics such as percentages, and frequency distribution and ordinary least square regression model were used to analyze the objectives.

Model Specification

Y = f(X1, X2, X3, X4, X5, X6, X7, X8---e_i)
Where Y= adoption level
X_1= age (Years).
X_2= household size (number of members).
X_3= farming experience (Years).
X_4= education level (Years spent in school).
X_5= level of Income (Naira).
X_6= farm Size (hectares).
X_7= membership to cooperative (1=yes, 0=no).
X_8= access to Credit (1=yes, 0=no)
e_i= stochastic distribution or error term.

Results and Discussion

Socio-Economic characteristics of respondents

The analysis on Table 1 showing the socio-economic characteristics of the rural women cassava farmers, reveal that majority of the respondents (66%) were within 20-39 years of age and 27% of the respondents were 40-59 years of age, while only 3% of the respondents were within 60-82 years of age. This indicates that majority of the respondents were in their active productive age, hence they can effectively engage in manual farm work. This agrees with the findings of Ekong (2003) who noted those young farmers are innovative and can adopt new innovations which increased income of the household. The analysis also reveals that majority of the respondents (79.17%) in the study area were literate with 45.83%, 16.67% and 16.67% of the respondents having received Primary, secondary and tertiary education respectively. However, 20.83% of the rural women cassava farmers did not obtain any formal education. Furthermore, the analysis showed that 50.00% of the respondents had 1-10 years of farming experience, while 37.50%, of the respondents had 11-20 years, of farming experience. It implies that majority of the women farmers were experienced in cassava farming. The experience gained could enable the farmers use their resources prudently and consequently enhance their adoption of value addiction to cassava Nwaru (2004). Table 1.0 further showed that majority (69.20%) of the respondent's belonged to cooperative societies, while 30.80% of the respondents were non-members of the societies. This means that membership to cooperative societies enhanced farmers adoption of the value added cassava technology. It agrees with a-priori expectation. Finally, the analysis revealed that most women farmers depended on household labour more than hired labour as was shown in table 1.0 this could impede production since most of the household members could be unproductive or belong to the dependent group. This agrees with Iheke, (2006).

Table 1: Distribution of Respondents Based on Socio-Economic Characteristics

Variables	Categories	Frequencies	Percentages
Age	20-39	72	60
	40-59	33	27.5
	60-82	15	12.5
Education	None	25	20.83
	Primary	55	45.83
	Secondary	20	16.67
	Tertiary	20	16.67
Farming Experience	1-10	60	50
	11-20	45	37.5
	21-30	9	7.5
	31-40	6	5
Membership of coop. Soc.	Yes	83	69.2
	No	37	30.8
Labour sources	Family labour	78	65
	Hired labour	42	35

Source: Survey Data 2013

Factors influencing the level of adoption of cassava value added innovations

The OLS regression analysis results for determinants of adoption of NRCRI's value added cassava technologies are shown in Table 2. The double- log functional form was chosen as the lead equation because the R square value was highest at 0.970 indicating that 97% of the observed variations in the resultant output are explained by the included variables. In the model four out of the eight explanatory variables were statistically significant at various levels of probability. The result showed that farming experience (0.078) was positively related to the level of adoption of value-added cassava technologies at 1% level of significance. This implies that level adoption increased with increase in years of experience of the farmers. This agrees with a-priori expectation and was supported by Ironkwe (2010) who opined that increase in years of experience led to increase in the use of new technology. More so, the analysis showed that level education (0.137) had a positive relationship with level of adoption at 1% level of significance. This means that as farmers' level of education increases, the level of adoption also increases. It is in line with a-priori expectation and agrees with the findings of Ironkwe, (2010) and Onuk et al, (2010), which say education enhances adoption. The result also showed that income (2.679E-5) was positively related to the level of adoption of the value- added cassava technologies and was significant at 1% level of probability. This indicates that as income increases, the level of adoption of the innovations will also increase. Again this agrees with a-priori expectation, since most of these value-added technologies are cost intensive. It is also in agreement with Ekong (2003) that confirmed a positive relationship between level of income and adoption of innovations. Furthermore, the result showed that membership to cooperative (1.039) was positively related to the level of adoption of the value- added cassava technologies at 1% level of significance. This implies that as more of the rural women join cooperatives, the more their adoption level increases, this agrees with a prior expectation and agrees with the study of Ekong (2003), who found out that farmers who participated in cooperative tend to adopt agricultural innovation more than those farmers who are not members. According to the result, age (-0.086), had a strong negative relationship with adoption of the value added cassava technologies and was significant at 1% level of probability, which means as the age of the rural women increases, their adoption level decreases. This is in accordance with a-priori expectation but disagrees with the work of Ekumankama (2002) who opined that a direct relationship exists between age the level of adoption of improved agricultural technologies. Table 2 also, revealed that Household size (-0.048) showed a negative relationship with the level of adoption of value added cassava technologies and was significant at 1% level of probability. This implies that as the household size increases, the level of adoption decreases. This also disagrees with the findings of Onuk *et al* (2010) who noted that increase household size, increased adoption. It could be that be that the members of the household fall into the dependent category and so cannot add to the household labour of the farmer.

Table 2: OLS multiple regression estimates of factors that influenced the level of adoption of Cassava Value-added innovations by rural women in Abia State.

Variables	Coefficient	Standard Error	t-value
Constant	0.086	0.559	0.150
Age	-0.121	0.034	-3.559***
Household Size	-0.048	0.018	-2.666***
Farming experience	0.078	0.018	2.731***
Education	0.137	0.029	6.225***
Income	2.68E-05	0.022	2.968***
Farm Size	-0.184	0.000	-1.528
Membership of coop. Soc.	1.039	0.120	7.865***
Access to Credit	0.086	0.132	0.635
R^2	0.970	0.136	
R adjusted	0.968		
F-statistics	444.279		

Source: Survey data, 2013; ***=sig. 1%, **= sig. 5%, *=sig. 10%

Challenges associated with the adoption level of value added innovations

The analysis of the factors that constrain the adoption of value added innovations as shown in Figure , revealed that constraints such as high cost of modern processing facilities (23.08%) was the major problem affecting the level of adoption of value added cassava technologies. This was followed by inadequate storage facilities as indicated by 20.60% of the respondents. Furthermore, 19.35% of the respondents indicated that inadequate capital was the problem that affected their adoption of value added cassava technologies.

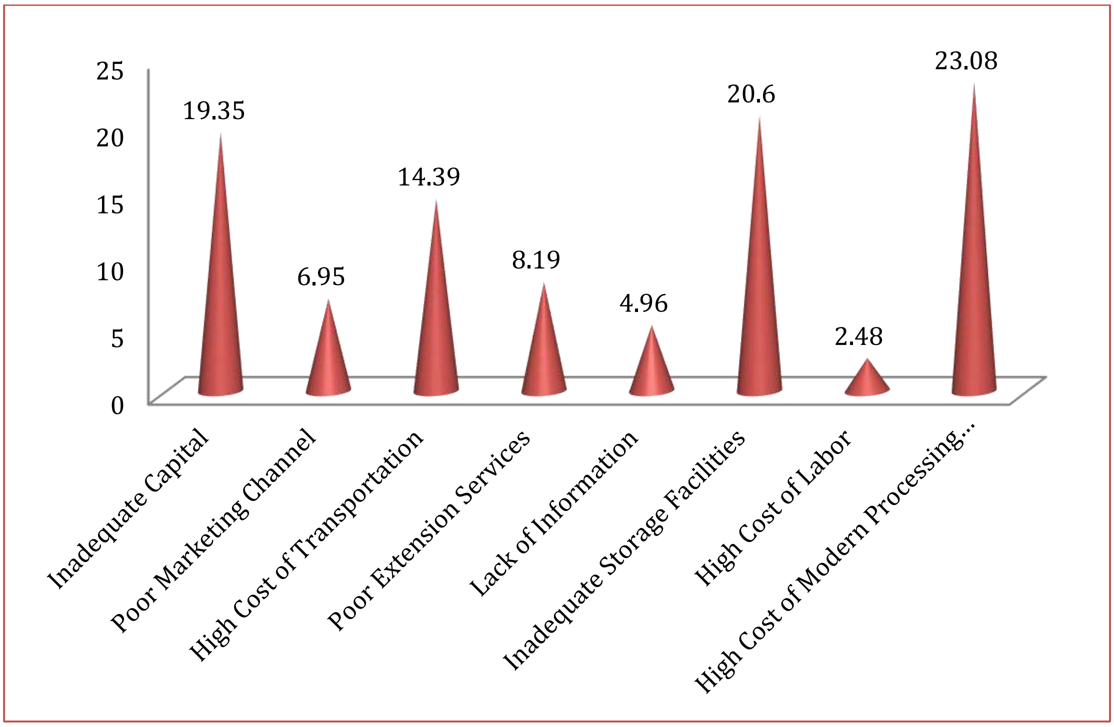

Figure 1: Problems Encountered by Rural Women Farmers in the Adoption of Value added

Conclusion

This study showed that the major determinants of adoption of NRCRI'S value added cassava technology were age, household size, years of experience, education, income and membership to cooperative. The study therefore recommends that more awareness be created in the study area about the technology. The trainings should target mostly the youth to reduce youth restiveness and unemployment. Government should provide sufficient credit to enhance rural farmers' adoption of the technology which require some capital.

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Performance of Unified Agricultural Extension System and Policy Implementation for Sustainable Agricultural Development in Owerri Agricultural Zone, Imo State

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Abstract
The study investigated the extent of performance of the Unified Agricultural Extension System of the Agricultural Development Programme (ADP) in policy implementation from 2007-2010; for sustainable agricultural development in Owerri Agricultural Zone of Imo State. The study also sought the extent of achievement of the ADP's set targets as well as constraints faced, in its extension delivery service. The respondents which included 53 extension stakeholders were involved in the study. Structured questionnaires, as well as ADP set-target and achievement records were made use of. Data collected were analyzed using simple Percentages, Mean and frequency distribution. Chi – square statistic(x^2) was used to test the hypothesis which stated that there is no significant difference between the ADP's set targets and achievement by the system. This was tested at 0.05 level of significance. The results of the finding showed that there is significant difference between the ADA set targets, and their achievements ($P< 0.05$)..Most of the set-targets were either not achieved, or only partially achieved. It was recommended among other things, that for sustainable agricultural development, relationship between research and extension should be strengthens and for effective extension service delivery and policy implementation. More qualified youths should be employed to strengthen the system, with extended motivational incentives. There should be regular training and retraining programmes for stakeholders to enhance knowledge, with programmes monitored effectively.

Keywords: Performance, Unified Agricultural extension, Policy implementation and Sustainable Agricultural Development

Introduction
The quest for sustainable agricultural development has been a big challenge facing many developing countries mostly in Africa and Asia. It has been observed that for the country to catch up with its food crisis there has to be 4% annual increase in food production level, as against 2.5% annual population increase. Attempts have been made in the past by various governments to enhance food production through intensive agricultural extension service delivery. The overall objective was to ensure adequate food supply for the teeming population, and to achieve a sustained and positive contribution of the agricultural sector to the Gross Domestic Product (GDP). According to Agbamu (2005), Agricultural Extension has been the handmaid of agricultural research. Regrettably, the ability of extension to bring about the much needed increase in agricultural productivity has been in doubt. Asiabaka (2002) posited that Agricultural Extension should aim at teaching rural and urban clientele, how to determine their problems, and be able to rise above such problems using their own resources. The basic goal of training and visit (T& V) system, is to build a professional extension service that is capable of assisting farmers in raising agricultural production, and/or income, and of providing appropriate support to agricultural development (Benor 1987). Agbarevo and Obinne (2010) agreed and stated that this is the mandate of the Agricultural development project, a parastatal of the Federal Ministry of Agriculture. The goal of the Agricultural Transformation Agenda as highlighted by Nwaiwu (2016), is to empower the youth in Nigeria through the full realization of the potential of cassava, rice and sorghum value chains for employment/income generation and food security, especially among some of the country's poorest and most vulnerable population. Adesope

(2007), acknowledged the role of extension in sustainable agricultural and rural development. It contributed that in order to alleviate the poverty situation in many rural areas of Nigeria, there is need to identify the indigent persons through participatory survey, and determining the type of skill that will help the individuals and their communities. Behaviour of farmers can be positively influenced through compulsion, coercion, manipulation, or by providing services. The farmers cannot solve their problems because of their insufficient or limited knowledge, but do so if they are exposed to more knowledge (Nwachukwu and Onuekwusi 2005).

Methodology

The performance of the Unified Agricultural Extension System of the Agricultural Development Programme (ADP) in policy implementation, from 2012-2015 was investigated. This is in view of the impact for sustainable agricultural development in Owerri Agricultural Zone of Imo State, where the study was delimited. The Owerri Agricultural zone is one of the 3 zones in Imo state. Others include Orlu and Okigwe Agricultural zones, under the ADP structure. The Owerri Agricultural Zone consists of 18 blocks in the ADP structure, with Agricultural Extension staff for effective extension delivery to farmers. The zone lies within latitude 50^0 15′N and 50^0 45′N and Longitude 60^0 45′ and 70^0 30′E. The 18 blocks in the zone include: Owerri-Urban North, Owerri-Urban South, Mbaitoli West, Mbaitoli East, Ikeduru East, Ikeduru West, Oguta, Egbema/Agwa, Umuokanne, Obosima, Obibi/Ihiagwa, Umuneke-Ngo, Obokwe, Ahiazu, Aboh-Mbaise, Ezinihitte, Okeuvuru, and Emekuku. Each block has a minimum of six (6) cells/circle, and a maximum of eight (8). An annual rainfall of about 1,600mm is recorded, and the area endowed with fertile soil and undulating topography. The zone is headed by a Zonal Manager, each of the blocks by Block Extension Supervisors (BES), while the cells/circles are manned by Extension Agents (EA). The Block Extension Agents (BEAs) are eighteen (18) in number for women in Agriculture Programmes. The sample size comprised all the fifty three (53) Extension Officers, purposively selected for the study: BESs 12, BEAs 18, EA's 23. Primary data were collected through interviews with officials of ADP, and Extension staff at the zonal office. Secondary data source included available performance record from the zonal office on forth-nightly training (FNT) and Monthly Technology Review Meeting (MTRM) of the extension staff. Data analysis methods include percentage and Chi-square statistics.

Percentage (%) $= \frac{f}{n} \text{ x } \frac{100}{1}$

Where: f = Frequency of response
n = sample size
100 =basis for percentage

Chi-square (X^2) model: $X^2 = \sum_i^n \frac{(o-e)^2}{e}$

Where: o = observed frequency
e = expected/theoretical frequency
n= sample size
$\sum_i$ = summation

This model was used to test the hypothesis that there is no significant difference between the ADP's set objectives and their achievement by the EAs.

Results and Discussion

The data on gender characteristics in Table 1 indicated that 43% of the respondents are males, with the frequency response of 23, while the frequency response for females is 30 (57%). The higher number of female respondents than that of the males shows that men prefer to engage in other businesses with quicker returns. This is a positive development in view of the fact that women play significant roles in national agricultural output, environmental sustenance, and family food security, processing and utilization.

Table 1: Distribution of respondents according to gender

Sex	Frequency	Percentage (%)
Male	23	43
Female	30	57
Total	53	100

Source: Field survey data

The Chi-square (X^2) statistics in Table 2, gave information on the differences between the ADP set targets, and their achievements by the Extension staff, from 2012 to 2015. The hypothesis was tested at 0.05 level of significance.

Table 2: Extension activities in 2012

O	E	Df	X^2-Cal	X^2-tab	Decision
13,468	25,031	6	159.21	12.59	Ho: rejected P<0.05

Source: Field survey data

Table 3: Extension activities in 2013

O	E	Df	X^2-Cal	X^2-tab	Decision
1936	9788	6	1465.73	12.59	Ho: rejected P<0.05

Table 4: Extension Activities in 2014

O	E	Df	X^2-Cal	X^2-tab	Decision
8498	18524	6	1040.5	12.59	Ho: rejected P<0.05

Table 5: Extension Activities 2015

O	E	Df	X^2-Cal	X^2-tab	Decision
19828	26595	6	888.2	12.59	Ho: rejected P<0.05

From the data in the Chi-square Tables 2 to 5, it can be observed that the hypothesis was tested at 0.05 level of significance, using 6 as the degree of freedom (Df), while the critical table value is 12.59. The calculated chi-square values are 159.29, 1465.73, 1040.5, and 888.2 respectively. In all instances, $P<0.05$. Since the critical table values are less than the calculated chi-square values in all the years (2012-2015). The null hypothesis is rejected in all cases. This implies that there is significant difference between the ADPs set targets, and their achievements by the Extension Officers. Most of the targets were not achieved. Some of the performance indicators include: Trainings and re-training of Extension personnel through the fortnightly training (FNT), Monthly Technology Review Meeting (MTRM), field visits, field days, group formation, communication support, etc. The targets of achievements were rarely met in most areas. Paucity of funds, poor facilities, lack of motivation, among other factors, could be attributable to this problem. Chukwunta (2003) is of the opinion that poor funding at the state level, inadequate staffing due to poor remuneration; inadequate input, etc. limit the effectiveness of the system. Venkatesan (2004) recognized the fact that regular training of farmers has positive impact on sustainable agricultural development. He stated that the actualization of training goals and overall success in technology transfer to farmers depends largely on adequacy of extension contacts. Adams (2000) contributed that for an extension worker to be able to carry out his duties diligently, proper education and training is necessary.

Conclusion

The study which covered 2012-2015, focused on the performance of the unified agricultural extension system in policy implementation for sustainable agricultural development in Owerri Agricultural Zone. Fifty three (53) extension officers constituted the sample size, purposively chosen. Interview and available data on extent of achievement of set targets formed the main instruments for collection of data. Simple percentage and Chi-square statistic were the major tools for data analysis. The results obtained showed that there is significant difference between the ADP's set targets and their achievement by the extension officers. This implied that most of the set targets could not be achieved, due to some identified constraints. The inability of the ADP and the extension staff to live up to their responsibilities is a threat to sustainable agricultural development. It should be realized that extension is weak, and can only be effective and strong if the essential ingredients of motivational incentives, input supply, credit, etc are made available. For a sustainable agricultural development, relationship between research and extension should be strengthened. More qualified youths should be employed to strengthen the system. Motivational incentives should be made available to the extension staff, for more input. There should be a mechanism for effective monitoring of extension programmes of activities. For meaningful knowledge enhancement, there should be regular training and retraining programmes for stake-holders in the system.

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APPENDIX

SYSTEM EMPLOYED IN ASSESSMENT OF AGRICULTURAL EXTENSION AGENTS USING THE CHI-SQUARE MODEL (X^2)

Extension Activities 2012—2015

Performance Indicators	O	E	Row Total
Trainings	64 (46.5)	69 (86.5)	133
Spats Situation	912 (1028.5)	2028 (1911.5)	2940
MTPs	1069 (1089.7)	2046 (2025.3)	3115
Field Visits	11184 (11065.7)	20448 (20566.3)	31632
Field Days	36 (62.97)	144 (117.0)	180
Group Formation	48 (84.7)	194 (157.3)	247
Communication Support	155 (89.9)	102 (167.1)	257
Total	13468	25031	38499

$$X^2 = \sum_{i}^{n} \frac{(oi-ei)^2}{ei}$$

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Analysis of Adoption of NRCRI Improved Cassava Technologies among Small-Holder Farmers in Ikwuano LGA, Abia State, Nigeria

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Abstract
The study was carried out in Ikwuano LGA of Abia State on analysis of adoption of NRCRI improved cassava technologies among farmers in Ikwuano LGA, Abia state, Nigeria. A multi-stage random sampling procedure was used to select 120 cassava farmers from 28 communities and purposive sampling method was used to select 4 communities for the study. The data collected were analyzed with descriptive statistical tools such as percentage, mean and frequency distribution for socio economic characteristics and Likert scale for analysis of adoption. The results of technology adoption showed that the farmers accepted all of the given improved technologies. The most important technology accepted was time of harvesting (4.3) which ranked the highest, followed by time of weeding (4.18).
Keywords: Adoption, NRCRI, Improved cassava technologies and farmers

Introduction
Cassava is an important staple in Nigeria and perhaps the most versatile staple in terms of the variety of products derived from it and the uses to which these products can be put. Garri is the major food product derived from cassava. Cassava pellet is an important animal feed, while starch, another derivative is important industrially. Cassava leaves are also consumed as vegetable (Jones, 1959; Fresco, 1986; Dostie *et al*., 1999; Haggblade and Gelson, 2003). Iheke and Nwaru (2013*)* confirmed this fact by their augment that innovation adoption is the key to increasing farm productivity. One of the strategies for poverty reduction through increased agricultural productivity is to promote the production of high yielding crop varieties (Nkonya et al., 2004).

Methodology
This study was conducted in Ikwuano LGA area of Abia State Nigeria. Ikwuano is a local government in Abia State, Nigeria. Its headquarters is in Isiala-Oboro. The coordinates of Ikwuano lies between 5^{o}, 25' N, and 7^{o} 34' E. It has an area of 281 km^{2} and an estimated population of 137,993 (NPC 2006). The study was carried out using purposive and multi-stage random sampling method to select the sample size. Four communities out of the 28 communities were selected thus: Umuariaga, Amawom, Ndoro, and Isiala respectively. These villages were selected because they are predominantly cassava growers in the study area. Two villages were randomly chosen from each community, making eight villages used in the study. 15 cassava farmers were randomly selected, totaling 120 cassava farmers that were used for the study. Primary data were used for this study. The data were generated through a well-structured questionnaire. The data collected were subjected to both descriptive and quantitative analysis. Data were analysed using descriptive statistic tools like frequency tables, means and percentages and Likert rating scale: The levels of adoption by the respondents were measured by using the seven point Likert scale:
Unaware (0), Aware (1), Interest (2), Evaluation (3), Trial (4), Adoption (5),and Rejection (6)
To determine the mean of adoption level $X = \sum x$; the mean score X, of each item was computed by multiplying the frequency of each response pattern with its appropriate nominal value and

dividing the sum with the number of respondents to the items. This can be summarized with the equation thus;

$$X = \frac{\sum fn}{n}$$

Where X = Mean score
∑ = Summation
N = frequency
n = Likert nominal value

$$X = \frac{0 + 1 + 2 + 3 + 4 + 5 + 6}{7} = \frac{21}{7} = 3.0$$

Results and Discussion

The result in Table 1 shows that majority (65.83%) of cassava farmers in the study area were males while 34.17% were females. 8.33% of the farmers were less or equal to 30 years and 35.83% were within the range of 31-40 years. Thirty percent were within the range of 41-50 years of age, 19.16%, within the range of 51-60 years of age while 6.66% were more than 60 years old. According to Bonabanna (2002), there seems to be contention on the direction of the effect of age on adoption. Nwaru, (2004), argues that the ability of a farmer to bear risk and be innovative has been reported to decrease with age. 4.16% of the farmers had no formal education, 10.83% had primary school education 20% had secondary education while 65% had tertiary education. Literate farmers tend to dominant in the study area. Educated farmers are expected to be more receptive to improved farming techniques. Imoh and Essien (2005) opined that educated farmers have more sources of information than their non-educated counterparts and are expected to adopt technologies faster than their non- educated counterparts. 22.5% had farming experience within the range of 1-5years, 41.57%, 6-10years, 20.85%, 11-15years, while 15% had over 15years. Adoption levels, ability to bear risk and the level of confidence a farmer can muster is predicated on his farming experience. 13.33% had a farm size of less than one hectare, 81.67% 1-5 hectares, 3.33% , 6-10; while 1.67% had farm size of more than 15 hectares. Cassava production in the study area is dominated by small-holder cassava farmers with farmlands ranging from 1-5 hectares. 29.17% of respondents in the study area had no contact with extension agents, 51.67% of respondents had contact with extension workers within the range 1-3 times, 14.17% 4-6 times, 3.33% between 7-9 times ; while 1.67% had more than 9 times. 46.67% of the respondents were members of a co-operative society, while 53.33% were not. 74.17% of the respondents had between ₦ 10,000- ₦ 50,000 as farm income, while 17.5% had between N51, 000-N100, 000, 5% had between ₦ 101,000- ₦ 150,000 whereas 3.33% had ₦ 151,000- ₦ 200,000. Increased level of farm income is a precursor in the sustenance of the adoption of improved technologies. 18.3% of the respondents had household size number ranging from 1-3. 55.8% 4-6, 19.17% of the respondents had household size ranging from 7-9, while 6.67% of the respondents had household size of more than 9 respectively. Majority (55.8%) had large household size of 4-6.

Table 1: Frequency distribution of respondents according to Socio-Economic Characteristics

Variable	Frequency	Percentage
Gender		
Male	79	65.83
Female	41	34.17
Total	120	100
Age		
≤30	10	8.33
31-40	43	35.83
41-50	36	30.00
51-60	27	19.16
>60	8	6.66
Total	120	100
Farming experience		
1-5	27	22.5
6-10	50	41.67
11-15	25	20.83
>15	18	15.00
Total	120	100
Farm size		
≤ 1	16	13.33
1-5	98	81.67
6-10	4	3.33
11-15	-	-
>15	2	1.67
Total	120	100
Extension contacts		
No extension contact	35	29.17
1-3	62	51.67
4-6	17	14.17
7-9	4	3.33
>9	2	1.67
Total	120	100
Membership		
Yes	56	46.67
No	64	53.33
Total	120	100
Income **(₦)**		
10,000-50,000	89	74.17
51,000-100,000	21	17.5
101,000-150,000	6	5.00
151,000-200,000	4	3.33
Total	120	100
Household **size**		
1-3	22	18.3
4-6	67	55.8
7-9	23	19.17
>9	8	6.67
Total	120	100

Source: Field Survey, 2017

Table 2 shows that the farmers in the study area accepted all of the given improved technologies. The most important technology accepted was time of harvesting (4.3) which ranked the highest, followed by time of weeding (4.18). Others are: fertilizer application (4.1), use of improved varieties (4.08), stem preparation (3.93), planting date (3.92), Land preparation (3.89), and planting distance (3.83), with the least accepted technology being: time of herbicide application (3.61).

Table 2: Rating Scale Analyses of adoption of improved cassava technologies in the study area

Tech.	0 Unaware	1 Aware	2 Interest	3 Evaluation	4 Trial	5 Adoption	6 Rejection	Total	Mean	Decision
Improved varieties	0(0)	21 (21)	5(10)	-	11(44)	83(415)	-	490	4.08	Accepted
Land preparation	-	23(23)	3(6)	10(30)	12(48)	90(360)	-	467	3.89	Accepted
Stem preparation	-	19(19)	8(16)	4(12)	20(80)	69(345)	-	472	3.93	Accepted
Planting date	-	16(16)	6(12)	9(18)	25(100)	65(325)	-	471	3.92	Accepted
Planting distance	-	18(18)	12(24)	4(12)	24(96)	62(310)	-	460	3.83	Accepted
Time of herbicide application	0(0)	17(17)	7(14)	21(63)	16(64)	55(275)	-	433	3.61	Accepted
Fertilizer application	-	17(17)	-	12(36)	16(64)	75(375)	-	492	4.1	Accepted
Time of weeding	-	12(12)	4(8)	8(24)	23(92)	13(65)	-	501	4.18	Accepted

Source: Field Survey, 2017
If; X ≥3: We accept showing adoption of the given technology.
If; X < 3: we reject showing rejecting the given technology.

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Farmers' Knowledge of Agrochemicals for Seed Yam Production in Umuahia South Local Government Area of Abia State, Nigeria

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Abstract
The paper examined farmers' knowledge of vital agrochemicals for seed yam production in Umuahia South Local Government Area of Abia State, Nigeria. Two-stage sampling procedure was adopted in selecting respondents for the study which gave rise to a sample size of 120 respondents. Data were generated from the respondents through use of structured questionnaires. The data obtained for the study were then analysed using descriptive statistics. Results of the analysis showed that respondents rated high their knowledge of agrochemicals used in weed control and inorganic fertilizer for seed yam production. Also, farmers perceived use of agrochemicals for seed yam production to be unsafe (dangerous to humans), not readily available and costly. It was therefore recommended that both extension agents and other relevant government agencies should also educate farmers on types and functions of agrochemical as well as their safety measure when in use.
Keywords: Farmers, knowledge, Agrochemicals, and Seed yam

Introduction
Researchers in Nigeria of the National Root Crops Research Institute (NRCRI), Umudike, and IITA, Ibadan, developed the minisett technique to overcome the critical problem of the unavailability of good quality seed yam by improving the rate of multiplication of white yam. With the technique, the multiplication ratio can increase from the traditional 1:5 to 1:30 (Orkwor et al. 2000). The minisett technique involves the cutting of 'mother' seed tubers into small setts (minisetts) of 25-40 g which must possess a reasonable amount of peel (periderm) from which sprouting can occur. The minisetts are treated with chemicals to prevent damage from diseases and pests, planted, and managed to produce small whole seed tubers; these in turn are planted to produce ware tubers for food. The minisett dust which are fungicides, insecticides and nematicides are agrochemical used in the minisett technique for seed yam production and has been reported as not being readily available to farmers hindering the adoption of the technique if famers cannot access the various components. Again, use of agrochemicals (such as minisett dust, herbicides inorganic fertilizer etc) is very prominent and indispensable in the improved technology for seed yam production. This implies that the accessibility of the agrochemicals to farmers enhances the adoption of the technology. Consequently, non-use of agrochemicals in the practice of the minisett technology could compromise the expected seed yam yield and influence rejection of the technology. In view of fore going, farmers' knowledge of agrochemicals may have influenced seedyam production in the study area of Umuahia South Local Government Area. This paper is therefore conceived to examine the farmers socio-economic characteristics as well as their knowledge of vital agrochemicals used for seed yam production in Umuahia South Local Government Area of Abia State.

Methodology
The study was carried out in Umuahia South Local Government Area (LGA) of Abia State, Nigeria. The LGA has a land area of 140km^2 and a population of 138,570 people at 2006 census. Two-stage sampling procedure was adopted in selecting respondents for the study. The first stage was selection of 10 out of 20 communities that make up the study area by simple random sampling

technique. The next stage was random sampling of 20 respondents from each of the 10 sampled communities in the area. These procedures gave a sample size of 120 respondents for the study. Data for the study were generated from the respondents through structured questionnaires. Farmers' knowledge of agrochemical were captured with 4-point Likert type measurement scale. These included 'very much knowledge' assigned the highest scale of 4… graded downwards to 'very little knowledge' with lowest scale of 1. The values of the 4 responses were added and further divided by 4 to obtain 2.50 which was regarded as the benchmark for decision rule. Thus knowledge mean scores below or above the 2.5 benchmark indicated the level of knowledge as either much or little respectively.

Results and Discussion

Socio-economic characteristics of farmers

Results presented in Table 1 shows that 38.3% of the farmers were females and 61.7% were males. Analysis of the respondent's sex revealed that the farming activity in the study area was dominated by males. This was expected since yam farming requires lots of energy and is culturally driven by the men. The results from Table 1 also showed that those within ages of 50-59 years constituted 53.3% of the respondents while the mean age of the respondents was 48.22 years. This means that majority of the farmers were ageing. Table 1 also reveals that most (65.8%) of the farmers in the area were married while 9.2% were single and 20.0% were widowed. The distribution of household size of the respondents gave a mean household size of 5 members per household. It further shows that more than half (57.5%) of the respondents has household size of 6-10 members.

Farmer's educational attainments showed that 15.0% of the farmers had no formal education; while more than half (52.5%) attended primary school. However, Oluwatusin and Shitu (2014) had reported high proportion of illiteracy among yam farmers in Western Nigeria.

Table 1: Distribution of respondents according to their socio economic characteristics

Variable	Frequency	Percentage	Variable	Frequency	Percentage
Sex			**Marital status**		
Female	46	38.33	Single	11	9.2
Male	74	61.66	Married	79	65.8
Age			Widowed	24	20.0
20-29	7	5.83	Divorced	6	5.0
30-39	16	13.33	**Household size**		
40-49	29	24.17	1-5	69	57.5
50-59	64	53.33	6-10	44	36.7
60-69	3	2.49	10 and above	7	5.8
70-79	1	0.83	Mean	5.2	
Mean	48.22		**Membership of Organizations**		
Educational level			Yes	89	74.2
Non-formal	18	15.0	No	31	25.8
FSLC	63	52.5	**Farming experience**		
WAEC/GCE	14	11.7	1-5	14	11.66
OND	12	10.0	6-10	28	23.33
HND/BSc & Above	13	10.8	11-15	60	49.98
Annual income (N)			16 and above	18	14.99
50,000 and less	77	64.16	Mean	12.77	
51,000-100,000	21	17.45	**Farm size (ha)**		
101,000-150,000	16	13.33	<1.0	24	20.0
Over 150,000	6	4.99	1.0-1.9	73	68.8
Mean	50981.25		2.0-2.9	12	10.0
Extension Visits			3.0-3.9	9	7.5
Weekly	2	1.67	4.0 and above	2	1.7
Fortnightly	7	5.83	Mean	2.10	
Monthly	16	13.32			
Quarterly	28	23.33			
Yearly	67	55.83			

Source: Field Survey Data, 2016.

The results further showed that 49.9% of the respondents had farming experience of 11-15 years while 23.3% indicated between 6-10 years' experience in farming. This implied that the farmers in the study area had been engaged in one form of agriculture or the other which means that they must have acquired good farming experience. Also, Table 1 showed the distribution of respondents' based on level of participation in social organizations. Results revealed that 74.2% of the respondents belonged to one farmers' association or the other. One of the roles of the farmer's organizations is to boost knowledge sharing among members. However, not all farmers are aware of the importance of being a member of such organizations. These farmers' organizations are effective channels of communicating information to farmers (Arimi, 2014).

Respondents' knowledge of common agrochemicals used for seed yam production
Table 2 below shows respondents' knowledge of common agrochemical used in seed yam production in the study area. From the results, the mean score value of 2.26 was less than the benchmark of 2.5 thus suggesting that generally farmers have little knowledge of common agrochemicals used in seed yam production. Specifically farmers have much knowledge of common agrochemicals used in weed control (2.68) and inorganic fertilizer (especially NPK) (2.67). This high rating could be attributed to the common practice of weed control as well as the high use of inorganic fertilizer for crops production by farmers in the area. The findings agreed with Nonga *et al.* (2011) who reported that most farmers have knowledge of the type, handling and applications of the agrochemicals which they usually obtain from the agrochemical shop owners. Nevertheless, it could be observed from the results that the farmers had litle knowledge of the common agrochemicals used for insect control (2.35); disease control (1.95) as well as limes (1.75) used to control soil acidity.
Similarly, the results revealed that more than one-third (38.5%) of the respondents had no knowledge of the common agrochemicals used for seed yam production. This raises concern on the farmers' handling of such high risk products without basic knowledge. Nonga et al. (2011) had also reported that majority of the farmers (76%) were unaware of the effects of pesticides to the environment in Uganda.

Table 2: Common knowledge of agrochemicals used for seed yam production

Agrochemicals	So much knowledge	Much	Little	No knowledge	Mean (x)
Agrochemicals for weed control	50	17	19	35	**2.68**
Agrochemicals for insect control	18	47	11	44	**2.35**
Agrochemicals for disease control	7	27	35	50	**1.93**
Limes for acid soil	3	22	38	58	**1.75**
Inorganic fertilizer	18	47	11	44	**2.67**
Mean	**19(16%)**	**32(26.7%)**	**23(19%)**	**46(38.5%)**	**2.26**

Conclusion

Analysis of the respondents' knowledge of common agrochemicals in seed yam production showed high rating for agrochemicals used in weed control and inorganic fertilizer. In order to realise the full potentials of seed yam production and yam minisett technology, the researchers needs to address the issues identified in this study with regards extent of farmers knowledge and perception of farmers about agrochemicals used by the farmers. It is therefore recommended that both extension agents and other relevant government agencies should enhance farmers' knowledge of the agrochemicals for seed yam production by essentially educating them on types and functions of agrochemical as well as their safety measure when in use.

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SUB-THEME 11

GENDER MAINSTRAMING ISSUES AND STRATEGIES

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Differentials in Gender Roles among Cassava Processors in Imo State

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Abstract
This study investigated cassava processing in Imo State with a view to ascertaining, and presenting in a disaggregated manner inherent gender roles. Purposive and multi-stage random sampling techniques were used in the selection of 240 respondents comprising of 120 male and 120 females were involved in this study. Data collection was with a set of structured and pre-tested questionnaire and analyzed using descriptive statistical tools such as means, frequencies and percentages. Results indicate that most of processing operations including peeling, sieving, toasting, fermenting, cooking, pounding and wrapping are carried out mainly by women. Youths and men dominated grating and dewatering because they operated the machines used for these operations while youths assume prominence in washing of peeled roots, and played important part in sieving, toasting garri and pounding fufu. Gender gaps in cassava processing exist in the study area. In order to address these gaps, males in the state should be encouraged to be more involved in cassava processing through the mechanization of the entire process while at same time females should be encouraged through provision of credit facilities to own and access these processing machines.
Keywords:** **Men, Women, Youths, cassava processing, gender roles and socioeconomic characteristics

Introduction
Nigeria is the world's largest producer of cassava; its production is put at about 57.1 million metric tonnes in 2016 (FAOSTAT, 2018). Unfortunately, cassava roots are notorious for their content of varying amounts of potentially toxic cyanogens (Cardoso *et al*., 2005, CIAT 2007); and short shelf-life due to post-harvest physiological deterioration (Yimala *et al*., 2008; Njoku, *et al*., 2014); hence they have to be processed into non-toxic and more stable value added products. Cassava roots can be processed into many primary products like garri, fufu, tapioca chips, pellets, flour, alcohol, starch and cassava cake. Cassava processing is laborious but locally adaptable. It usually includes all or some of the following specific operations: peeling, washing, grating, dewatering, sieving, toasting, fermenting, cooking, pounding, wrapping, slicing, chipping, grinding and drying. Gendered power relations permeate social institutions such that gender is never absent as it deals with the social relationship between men and women and how these relationships are negotiated in the production of goods and services (Ironkwe *et al.,*2007). Such gender relations exist in cassava processing where men and women have different roles, priorities, opportunities and constraints. The cassava value chain reflects gender roles for men and women in value addition activities (Nweke and Tollens, 2002). There is insufficient disaggregated data on gender which could help in understanding gender differences in cassava processing. In addition, there is poor planning, monitoring and evaluation of development programmes targeted at different gender to increase productivity due to scarcity of necessary gender specific data (Ironkwe and Asumugha, 2007). This paucity of empirical disaggregated data on gender necessitated this study on gender roles in cassava root processing in Imo state Nigeria.

Methodology
This study was carried out in Imo State in South Eastern Nigeria. A purposive and multi-stage sampling technique was used in selecting two hundred and forty (240) cassava farmers

consisting of 120 males and 120 females. Instrument for data collection was a set of structured and pre-tested questionnaire. The primary data gathered included socio-economic characteristics of respondents like age, education, marital status, household size, farm size, quantity of roots processed, farming experience and membership of cooperative societies and gender roles in specific processing activities. Descriptive statistics were used to analyze the data generated from the study.

Results and Discussion

Socio-economic Characteristics of Cassava Processors in Imo State

The distribution of male and female cassava processors according to their socioeconomic characteristics is presented in Table 1. It is evident from the table that majority of the males (69.0%) and of females (70.0%) were within the age range of 20 to 49 years showing that respondents were within the active and productive work segment of the population. Age is known to be a primary latent characteristic affecting agricultural production and processing. Being aged (>60 years) is known to reduce the ability of a farmer to effectively withstand the rigours, strain and stress involved in agricultural production (Onyenucheya and Ukoha, 2007). Most (97.0% of males and 95.5% of females) of the respondents were literate at various levels with only a small proportion (3.0% for males and 5.0% for females) having no formal education. Cassava processing can be restrained or improved by the overall level of education of individual members of the household. According to Okoye *et al* (2004), education has the capacity to influence people to accept new technology and change their attitude to the desired technology. Majority (74.0% males and 77.0% females) were married. The preponderance of the married people could create potential for increased labour supply which would contribute positively to cassava processing. Amadi *et al*, (2016) observed that the married class does have access to extra financial, moral and physical supports from their spouses that could go a long way to improve their production activities. The most (83.0% for male and 77.0% for female) frequent household sizes ranged from 4-9 persons. This is in agreement with the report of other authors (Udensi *et al*, 2011). The mean household size of 7 reported in this study suggests availability of family labour in the study area. The availability of substantial family labour may reduce the cost of labour needed for processing. Average quantities of cassava roots processed weekly by male and female respondents were 147.0kg and 183.0kg respectively. More males (27.0%) than females (6.0%) did not process their roots implying that they sold off their roots for cash while women processed probably to feed their family. It appears that the major aim of women producing cassava was to feed their families. This finding and conclusions are corroborated by the report by Butterworth, *et al*., (2008). A sizable proportion (48.0%) of males had between 1-10yrs experience while a similar proportion (46.0%) of females had between 11-20 years of experience in cassava. Though female respondents have slightly more mean farming and processing experience (15.0yrs) compared to males (14.0yrs), both groups of respondents were established and knowledgeable in cassava processing. Farming and processing experience affect farm and processing managerial know-how and decision-making process. Khanna (2001) also noted that higher farming experience attainable through increased years of farming leads to higher rates of adoption of new agricultural innovation.

Table 1: Socioeconomic Characteristics of Cassava Processors in Imo State

	Male		Female	
Age (yrs)	**Frequency**	**Percent**	**Frequency**	**Percent**
<20	0	0	2	1.66
20-29	20	16.66	13	10.82
30-39	45	37.49	42	34.99
40-49	18	14.99	27	22.5
50-59	28	23.37	26	21.67
>60	9	7.49	10	8.36
Mean (years)	***40.63***		***41.29***	
Years in school				
0	4	3.35	6	5
1-6	40	33.33	28	23.34
7-12	43	35.83	45	37.51
13-16	29	24.17	26	21.67
≥17	4	3.32	15	12.48
Mean(years)	**10.26**		**11.45**	
Marital status				
Single	22	18.33	12	10.00
Married	89	74.17	92	76.67
Widowed	9	7.50	15	12.50
Separated	0	0.00	1	0.83
Household size				
1-3	3	2.5	6	5.0
4-6	48	40.0	42	35.0
7-9	51	42.5	50	41.67
10-12	14	11.67	18	15.0
13-15	4	3.33	4	3.33
Mean	**7.19**		**7.23**	
Qty of roots processed weekly (kg)				
0	32	26.67	7	5.83
1-500	83	69.17	105	87.5
500-1000	5	4.16	8	6.67
>1000	0	0.00	0	0.00
Mean(kg)	**146.58**		**182.50**	
Experience (Years)				
1-10	57	47.49	44	36.67
11-20	43	35.85	55	45.84
21-30	15	12.5	12	10.0
>30	5	4.16	9	7.49
Mean(years)	**13.89**		**15.43**	

Source: Field survey 2017

Gender Roles in Cassava Processing

The distribution of respondents according to their indication of who performs what role in cassava processing is presented in Table 2. Generally, women dominated most processing operations with youths and men playing complimentary roles especially where heavy strength is needed. This finding is in accord with the report of Ezeibe *et al*., (2015). Aminu *et al* (2017) found women to be technically more efficient in processing than men. An analysis of specific processing operations show that both male and female respondents indicated that peeling is carried out mostly by women (50.0% by males, 52.5% by females) and youths (31.0% by males, 40.0% by females) with men (6.0% by males, 3.0% by females) playing a negligible role. This finding is consistent with the report of Aminu *et al*, (2017). Peeling usually the first operation in cassava processing is time consuming and laborious. Men lack the patients to do such work. Youths assume prominence in washing of peeled roots as indicated by 62.0% of male respondents and 58.0% of female respondents. Next to youths in this role are women as indicated by 32.0% of male and 51.0% of female respondents. Men hardly partook in washing peeled roots as indicated by less than 5.0% of both male and female respondents. Grating of peeled cassava roots was carried out by mainly youths and men to a lesser extent as indicated by both male and female respondents. This finding is consistent with the report of Mgbakor and Nwamba (2013). Youths and men operated the grating machines as this was perhaps considered too complex, heavy and risky for women. Men and youths were also the main operators of the pressing or dewatering machines in the study area. However while female respondents indicated that youths (48.0%) were the major operators of the dewatering devices in the study area, female respondents gave it to men (43.0%). This is consistent with a similar finding by Ogunleye *et al*, (2008). Sieving which serves to breakup compressed mash of grated roots and remove un-grated fragments and fibres was carried out mostly by women and youths while men played a negligible role (Table 2). Majority of male respondents (50.0%) gave it to youth while majority of female respondents indicated that women played the dominant part in sieving. Both male and female respondents were in agreement that women played pivotal role in the toasting (frying) of dewatered and sieved cassava mash into garri. This finding is in agreement with other reports (Ogunleye *et al*., 2008; Taiwo and Fasoyiro, 2015) Youths also play a significant part in toasting grated cassava roots to produce garri. Fermenting operation as indicated by both group of respondents were carried out mostly by women and to a lesser extent youths with men playing negligible roles. Perhaps men considered this operation petty and not strength exerting hence they left it for women and youths. Cassava processed into gari undergoes solid state fermentation for about 3 days while fufu is a product of submerged fermentation in which whole roots or pieces of peeled roots are placed in water for 3-5 days. Fermentation process either by solid or sub-merged fermentation reduces the cyanide content of cassava (Imeh and Odibo, 2013). Women dominated cooking, pounding and wrapping of food. These activities as these were within their traditionally assigned roles going by the culture of the people in the study area. However the role of youths in pounding was significant perhaps due to the strong physical exertion involved. The dominant role of women in cooking and related activities have also been previously reported (Taiwo and Fasoyiro, 2015)

Table 2: Distribution of male and female respondents according to gender roles in processing

Gender Roles	Male		Female	
Peeling	***Freq.**	**Percent**	***Freq.**	**Percent**
Men	7	5.83	4	3.34
Women	60	49.99	63	52.5
Youths	37	30.83	48	40
All	41	36.16	44	36.67
Washing				
Men	5	4.16	4	3.34
Women	38	31.67	61	50.84
Youths	74	61.66	69	57.5
All	28	23.33	26	21.67
Grating				
Men	40	33.33	44	36.67
Women	23	19.17	28	23.34
Youths	65	54.17	55	45.84
All	25	20.83	25	20.83
Pressing				
Men	53	44.16	51	42.5
Women	14	11.66	22	18.34
Youths	57	47.49	43	35.84
All	22	18.33	30	25
Sieving				
Men	5	4.16	1	0.83
Women	56	46.67	71	59.17
Youths	60	50	60	50
All	24	20	24	20
Toasting				
Men	7	5.83	2	1.66
Women	78	65	90	75
Youths	53	44.16	43	35.83
All	17	14.17	22	18.33
Fermenting/Soaking				
Men	7	5.83	4	3.34
Women	96	79.99	99	82.51
Youths	27	22.49	25	20.84
All	14	11.67	17	14.17
Cooking				
Men	1	0.83	3	2.5
Women	115	95.83	108	90
Youths	25	20.83	28	23.33
All	5	4.17	11	9.17
Pounding				
Men	9	7.49	8	6.67
Women	86	71.66	91	75.83
Youths	55	45.83	48	39.99
All	15	12.5	13	10.83
wrapping				
Men	0	0	4	3.34
Women	99	82.5	99	82.5
Youths	37	30.84	39	32.5
All	16	13.33	14	11.67

Source: Field Survey 2018; Males: 120, Females: 120, *Multiple responses,

Conclusion

This study investigated the gender roles in cassava processing among farmers in Imo State, Nigeria. Men, women and youths played complementary roles in various operations involved in cassava processing. Women dominated most processing operations except mechanized grating and dewatering.

Gender gaps in cassava processing exist in the study area. In order to address these gaps, males in the state should be encouraged to be more involved in cassava processing through the mechanization of the entire process while at same time females should be encouraged through provision of credit facilities to own and access these processing machines.

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Poverty Profile and Needs Assessment of Women in Kaduna State, Nigeria

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Abstract
This study was conducted in 2018 and focused on Poverty Profile and Needs Assessment of Women in Kaduna State, Nigeria. The specific objective of the study was to analyze the livelihood status of women groups. The paper utilized primary data using the open data kit (ODK) application technique. The survey instrument was administered to ten women groups, ten respondents were randomly selected from each women group while five women leaders were also interviewed for the study. Descriptive Statistics such as frequency distribution, percentages and mean were used to achieve the stated objectives. Results showed that 42% of the respondents are in the active ages of between 17–31 years, 52% have a household size of between 1-10 members while about 53% of the respondents can read and write. Poverty profile showed that about 74% have no access financial institutions, 36% have access to owned land. Needs assessment revealed that majority, 63% of the women required capital ranging between one thousand to one hundred thousand naira to start their business, The paper argued that, although women contribute greatly in societal growth and development, however, their condition of poverty can be improved upon. It was suggested in conclusion that by providing them with loans; women poverty can be greatly reduced in Kaduna state.
Keywords: Women, poverty and Kaduna State

Introduction
Majority of the population in developing countries live in rural areas where there is myriad of individuals who continue to live in extreme poverty. Identifying the extent and nature of poverty requires a clear definition of poverty be established. In year 2000 the World Bank defined poverty as a 'pronounced deprivation in well-being'.Regardless of the fact that Nigerian economy is paradoxically growing, the proportion of Nigerians living in poverty is increasing every year (NBS, 2012). For instance, aggregate poverty rose from 28.3 % in 1980 to 69.3 % in 1996, declined to 63.3 % in 2004 and increased to 69.0 % in 2010 (Ogwumike and Akinnibosun, 2013). Soludo (2012) while making presentation at the stakeholders meeting on the Nigerian economy stated that "Very high levels of poverty is essentially a northern phenomenon".. The root causes of poverty need to be understood to design efficient measures tailored to the needs and strengths of poor people hence the study objectives include: to describe the socio-economic characteristics of women in the study area, describe the poverty status of women based on their livelihood strategies, and identify the types of intervention that are likely to be most appropriate for the different categories of poor women

Methodology
The Study Area
Kaduna State is located between latitude 09^0N and 11^0Nand between longitude 06^0E and 08^0E of the Greenwich meridian. The State has a population of 6, 113,503 people (NPC, 2006), the estimated projected population in 2017 is 8,645,035 people going by a population growth rate of 3.2% per annum. The State is agrarian with an annual rainfall of 1600mm (NAERLS, 2015). Giwa Local Government vegetation is made of up grasses and shrubs, majority of the people in the area are farmers. They produce both crops (maize, rice, sorghum, cowpea, soybean and vegetables) and livestock. Sabon-Gari Local Government has similar vegetation with Giwa Local Government,

where there is predominance of grasses and shrubs in the area. Crop and livestock production are the major occupation of the people in the area. Women in the two Local Government areas are engaged in processing of farm produce, handcraft and petty trading among others.

Sources of Data and Analytical Technique

The study was conducted among twenty (20) National Agricultural Extension and Research Liaison Services Adopted Villages and Schools Outreach women groups located in Giwa and Sabon Gari Local Government Areas of Kaduna State in 2018. Multi-stage sampling technique was employed in this study. In the first stage, five women groups were selected from each of the two local government areas based on availability of the members, making a total of ten women groups for the study. In the second stage, ten respondents were randomly selected from each women group while five women leaders were interviewed separately, making a total of two hundred and five respondents for this study. Computer assisted personalized interview (CAPI) technique using structured questionnaire was adopted to capture bio- data, poverty profile and the needs assessment of the respondents in the study area. In addition, focus group discussions with key informants were also conducted during the data collection for validation. Descriptive Statistics such as frequency distribution, percentages and mean were used to achieve the stated objectives.

Results and Discussion

Table 1 presents the socioeconomic description of the respondents in the studied areas. The result revealed that 42% of the respondents are between the ages of 17–31 years while, 37% were between 32–46 years of age. Based on the findings, it shows that majority of the women are either in their youth or productive age. Further, the best part of the respondents is married (91%). About half of the respondents (52%) have a household size of between 1-10 members, an indication of existence of nuclear family. Notably, about 84% of the women were spouses of the household head, it is worth mentioning that 1% of respondents were daughter in-laws of the household head. This suggests that the incidence of widowed or divorced women in the areas is nominal. About 53% of the respondents can read and write, grounded on discussion with the women, those that can read have at least JSS III certificate. This implies that women in the study sites can follow simple written instructions and other extension publications for better life. Half of the respondents (50%) own 6–10 children, while 46% had 1-5 children. About 77% of the women send a number of their children to school ranging from 1-5. Among the children in school, respondents reported that majority of them (73%) were attending public or government schools while only 12% had some of their children attending private schools. The implication of this is that there is dire need to further improve the education system in Nigeria to enable the rural poor obtain standard education. About 15% stated that they pay their ward's school fees, whereas 58% testified that their spouses pay the school fees. In other cases, it was a combined effort (14%). This shows that there is still no free access to education for the rural poor even at the primary level. Conversely, about 58% of the respondents have been members of groups for 1–5 years.

Table 1: Socioeconomic Characteristic of Respondents (n=205)

Variable	Frequency	Percentage
Age		
17 – 31 years	87	42.43
32 – 46 years	76	37.07
47 – 61 years	38	18.53
62 – 76 years	4	1.95
Marital Status		
Divorced	3	1.46
Married	186	90.73.
Widow	16	7.8
Household size		
1-10	106	51.7
11-20	79	38.53
21 – 30	19	9.26
31 – 40	1	1.04
Position in Household		
Heads of Household	27	13.17
Spouses of Head of Household	172	83.9
Daughter/Son In-law of Head of Household	2	0.97
Parent/In-law of Head of Household	3	1.46
Others	1	0.48
Ability to read		
Yes	109	53.17
No	96	46.82
Number of Children		
< 1	4	1.95
1 – 5	95	46.34
6 – 10	102	49.75
11 – 15	4	1.95
Children in School		
0	4	1.95
1 – 5	159	77.56
6 – 10	40	19.51
11 – 15	2	0.98
Type of School		
Public	149	72.68
Private	24	11.71
Public and Private	26	12.68
Others	6	2.93
Who Pay School Fees		
Father	118	57.56
Mother	30	14.63
Both Parents	29	14.14
Government	8	3.9
Siblings	20	9.76
Years in Group Membership		
Less than one Year	10	4.87
1 – 5 years	118	57.56
6 – 10 years	63	30.73
More than 10 years	14	6.82

Source: Field Survey, 2018

Poverty Profile among Women

The result in Fig. 1 gives the level of poverty of the women groups in the study area.

Own bank account

The result in figure 1 indicated about 74% don't own bank accounts, while only about 26% were found to own bank accounts. This implies that majority of the respondents interviewed were not interacting with financial institutions such as commercial banks and micro finance banks. This may also be due to their financial status which cannot warrant them to have bank account. They further stated that the money in their possession was very meager.

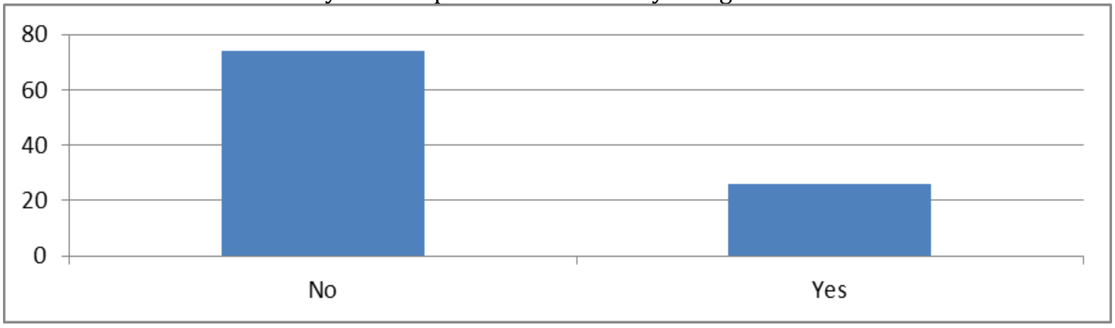

Figure 1: Ownership of Bank Account

Land ownership

The information in figure 2 revealed about 36% owned land through inheritance, about 32% rented the land under their control, 14% reported to have purchased their land. However, 15% of the respondents' land ownership was through other means like gift, lease and others.

Figure 2: Land Ownership Status

Livelihood sources

The following highlighted the various livelihood sources adopted by the women groups. The livelihood sources rest on their major occupations and other income generating activities engaged upon as at the time of investigation.

Figure 3: Major Occupation of women groups

Figure 3 shows that 37% of the women interviewed were traders, 33% were food processors, while only 8% participate in farming activities. Low mobility of women due to religious restrictions may be accountable to their low participation in farming activities.

Needs Assessment and type of Intervention

Table 2: Respondents Capital Requirement to Start Business (n=205)

Capital (N)	Frequency	%
0	59	28.78049
1-100000	129	62.92683
100001-200000	7	3.414634
200001-300000	3	1.463415
400001-500000	5	2.439024
500001-600000	1	0.487805
600001-700000	1	0.487805

Source: Field Survey, 2018

From Table 2, approximately 63% of the total population requires a minimum capital of between 1-100000 naira to start a trade while approximately less than 1% of the population require between 500001-600000 and 600001-7000000 naira respectively. Approximately 3%, 1% and 2% of the population require a minimum capital of between 100001-200000 and 200001-3000000 and 400001 and 500000 naira respectively while 28% requires capital less than 100000 naira.

Conclusion

Based on the findings of this study, it can be concluded that there is poverty and felt needs among rural women groups in the study area. This implies that more intervention projects effort should be geared towards improving the micro variables that will improve the welfares and living standard and reduce poverty level among the women in the study area.

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Analyses of Gender Roles in Cassava Production in Imo State

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Abstract
This study ascertained and described gender roles in cassava production in Imo State. Purposive and multi-stage random sampling techniques were used to select 240 respondents comprising of 120 male and 120 females involved in this study. Data were collected with a structured and pre-tested questionnaire and analyzed using descriptive statistics. Results from this study showed that while men dominated heavy energy operations such as land clearing and tillage, women dominated other operations like planting, weeding, harvesting and preparing food for farm use. Youths participated in most operations but rarely had access to and control of finances for cassava production. In line with the finding of this study, it is recommended that policy issues targeted at increasing cassava production in the state should advocate for more involvement of the males in especially those roles dominated by women and allowing youth's greater access to and control of finances for cassava production.
Keywords: Gender, Men, Women, Youths, Cassava production and Socioeconomic characteristics

Introduction
In Nigeria, wide adoption of high-yielding cassava varieties, better pest management and value addition technologies have resulted in a sharp rise in its production. In Imo State, it is one of the most important food crop cultivated and consumed widely. In most parts of rural Nigeria, division of labour within the household is gender-specific and according to age. Gender refers to socially constructed role differences between men and women usually for the purpose of allocating powers, duties, status, responsibilities and roles in any given social milieu or context (USAID, 2005). Such gender relations exist in agricultural production where men and women have different roles, priorities, opportunities and constraints. Lack of gender consideration has often led to failure of different popular projects in the past (Chukwu and Nwaiwu, 2012). Men and women perform different functions and roles in cassava production (FAO, 2007). These roles vary widely and are in many instances determined by culture and tradition (Ironkwe and Asumugha, 2007). There is also lack for disaggregated data on gender which could help in understanding gender differences in cassava production. In addition, there are poor planning, monitoring and evaluating development programmes targeted at different gender to increase productivity due to scarcity of necessary gender specific data (Ukeje, 2004; Ironkwe and Asumugha, 2007). This paucity of empirical disaggregated data on gender necessitated this study of gender roles in cassava production in Imo state Nigeria.

Methodology
This study was carried out in Imo State in South Eastern Nigeria. A purposive and multi-stage sampling technique was used in selecting two hundred and forty (240) cassava farmers consisting of 120 males and 120 females. Instrument for data collection was a set of structured and pre-tested questionnaire. The primary data gathered included socio-economic characteristics of respondents like age, education, marital status, household size, farm size, quantity of roots produced, farming experience and membership of cooperative societies.

Descriptive statistics such as mean, percentage, and frequency distribution were used to analyze the data generated from the study.

Results and Discussion

Socio-economic Characteristics of Cassava Producers in Imo State

The distribution of male and female cassava producers in Imo state Nigeria according to their socioeconomic characteristics is presented in Table 1. It is evident from the table that majority of the males(69.0%) and of females(70.0%) were within the age range of 20 to 49 years while 31.0% and 30.0% of them were within the ages of 50 years and above. The mean ages of male and female respondents were 40.6 and 41.3 years respectively. This result indicated that cassava farmers were mostly of middle age (30-59 years) hence, they are within the active and productive work segment of the population. Age is known to be a primary latent characteristic affecting agricultural production. Being aged (>60 years) is known to reduce the ability of a farmer to effectively withstand the rigours, strain and stress involved in agricultural production (Onyenucheya and Ukoha, 2007). Most (97.0% of males and 95.5% of females) of the respondents were literate at various levels with only a small proportion (3.0% for males and 5.0% for females) having no formal education. Cassava production and processing can be restrained or improved by the overall level of education of individual members of the household. According to Okoye *et al* (2004), education has the capacity to influence people to accept new technology and change their attitude to the desired technology.

The most frequent household sizes (83.0% for male and 77.0% for female) ranged from 4-9 persons. This is in agreement with the report of Ezeibe *et al*, (2015). Awoniyi *et al.* (2009) noted that large household sizes assist in providing family labour for cassava farmers, thus leading to a more efficient use of resources and higher output. Many of the respondents (52.0% males and 55.0% females) had farms whose sizes were less than one hectare. This is in agreement with the report of Onumadu and Onuoha (2015) who noted that the sizes of the land cultivated by majority of male and female farmers are in the range of 0.1 - 2.0ha. Ugwumba *et al*, (2010) asserted that small sizes of farms amongst smallholders in south Eastern Nigeria call for some form of land integration policy. The mean quantity of roots produced by males (191.0kg) was slightly higher than their female (182.0 kg) counterparts. This finding is in disagreement with Onumadu and Onuoha, 2015 who reported that in Abia state, female headed households produced more bags of cassava than male headed households. Many (48.0%) of males had between 1-10yrs experience while a similar proportion (46.0%) of females had between 11-20 years of experience in cassava production. Though female respondents have slightly more mean farming experience (15.0 yrs) compared to males (14.0 yrs), both groups of respondents were established and knowledgeable in cassava production. Farming experience affects farm managerial know-how and decision-making process. Khanna (2001) also noted that higher farming experience attainable through increased years of farming leads to higher rates of adoption of new agricultural innovation. Only 20.0% males and 18.0% females belonged to cooperative societies indicating that majority of the respondents did not. This finding is consistent with the report of Onyemauwa, (2012) which showed that about 72.0% of the respondents do not belong to, and take part in, cooperative activities. Since most agricultural technologies are provided to farmers who take part in cooperative activities, their non participation will likely constrain their production and processing activities (Tahirou *et al*., 2015).

Table 1: Socioeconomic Characteristics of Cassava Farmers in Imo State

	Male		**Female**	
Age (yrs)	**Frequency**	**Percent**	**Frequency**	**Percent**
<20	0	0	2	1.66
20-29	20	16.66	13	10.82
30-39	45	37.49	42	34.99
40-49	18	14.99	27	22.5
50-59	28	23.37	26	21.67
>60	9	7.49	10	8.36
Mean (years)	*40.63*		*41.29*	
Years in school				
0	4	3.35	6	5
1-6	40	33.33	28	23.34
7-12	43	35.83	45	37.51
13-16	29	24.17	26	21.67
≥17	4	3.32	15	12.48
Mean(years)	10.26		11.45	
Household size				
1-3	3	2.5	6	5.0
4-6	48	40.0	42	35.0
7-9	51	42.5	50	41.67
10-12	14	11.67	18	15.0
13-15	4	3.33	4	3.33
Mean	7.19		7.23	
Farm size (ha)				
< 1ha	62	51.66	66	54.99
1-3 ha	48	39.98	45	37.52
>3 ha	10	8.36	9	7.49
Mean(ha)	1.25		1.13	
Root production (kg)				
<500	96	79.98	97	80.82
500-1000	19	15.84	16	13.33
>1000	5	4.18	7	5.85
Mean(kg)	190.83		182.00	
Experience (Years)				
1-10	57	47.49	44	36.67
11-20	43	35.85	55	45.84
21-30	15	12.5	12	10.0
>30	5	4.16	9	7.49
Mean(years)	13.89		15.43	
Membership of Coop Societies				
Yes	24	20.00	22	18.33
No	96	80.00	98	81.67

Source: Field survey 2017

Gender Roles in Cassava Production

The distribution of respondents according to their indication of who performs what role in cassava production is presented in Table 2. Data presented show that most of the male (86.0%) and to lesser extent females (77.0%) respondents indicated that men select site for cassava production suggesting that the responsibility lies with men. This finding is in tandem with the land tenure system in the study area which vests ownership and authority over land on men. Majority of male (65.0%) and female (60.0%) respondents indicated that the responsibility for land clearing rests mainly on men with women and youths playing lesser role. Udemezue and Onwuneme (2017) also reported that men did most of land clearing for cassava production in Anyamelu LGA of Anambra state. Both male (42.0%) and female (41.0%) respondents indicated that burning after slashing was carried out mainly by men but with increasing involvement of women and youths. Uzokwe and Ofuoku (2006) also reported the increasing involvement of women in stubble burning in Delta State in the last decade. Men (39.0% by males and 41.0% by females) followed by youths (25.0% by males and 29.0% by females) do most of land tilling and preparation but women (19.0% by males and 22.0% by females) are also involved substantially. This finding is in agreement with similar research report of Ezeibe *et al*., (2015). Tillage is a heavy energy task hence men and their sons with inherent physic do most of the job. Women and to a much lesser extent youths did most of cassava planting operation as indicated by 51.0% and 13.0% of male and 42.0% and 15.0% of female respondents respectively. The trend was similar in weeding as indicated by 60.0% and 20.0% of male and 58.0% and 18.0% of female respondents respectively. These findings are in agreement with many previous reports (Lenis *et al.*2009, Udemezue and Onwueneme, 2017; Atser *et al*., 2017) which found women to be mostly engaged in planting and weeding. Both group of respondents indicated that herbicide application was mainly the prerogative of men and youths with 40.0 and 32.0% respectively from male and 44.0 and 23.0% respectively from female respondents. Harvesting was carried out by all (men women and youths) with women having a slight edge. The trend in response was the same for both male and female respondents. Ezeibe *et al*., (2015) however reported that women dominated the work of harvesting cassava in Abia state.

Table 2: Distribution of male and female respondents according to gender roles in Cassava Production

Gender Roles	**Male**		**Female**	
Site Selection	***Freq.**	**Percent**	***Freq.**	**Percent**
Men	103	85.84	92	76.67
Women	30	25	34	28.33
Youths	2	1.67	1	0.83
Land Clearing				
Men	78	64.99	72	60
Women	16	13.33	23	19.17
Youths	28	23.33	21	17.5
Burning				
Men	50	41.67	49	40.84
Women	28	23.34	37	30.83
Youths	20	16.67	12	10
Land preparation				
Men	47	39.16	49	40.84
Women	23	19.17	26	21.67
Youths	30	25	35	29.17
Planting				
Men	9	7.5	11	9.17
Women	61	50.83	50	41.67
Youths	15	12.5	18	15.01
Weeding				
Men	7	5.84	9	7.49
Women	72	60.01	70	58.33
Youths	24	20	22	18.33
Herbicide application				
Men	48	40.33	53	44.17
Women	19	15.96	25	20.83
Youths	38	31.93	27	22.5
Harvesting				
Men	21	17.5	17	14.17
Women	31	25.83	27	22.5
Youths	12	10	8	6.66

Source: Field survey 2017, N = 120 (Males), 120 (Females) 240 (Pooled), *Multiple responses.

Both male and female respondents are in accord as shown in figure (1) that women play a pivotal role in preparing food and taking it to those engaged at the farm. This finding is in tandem with the traditional role of women in the study area to cook for their families. This is a very important operation usually overlooked when accessing labour input in the farms.

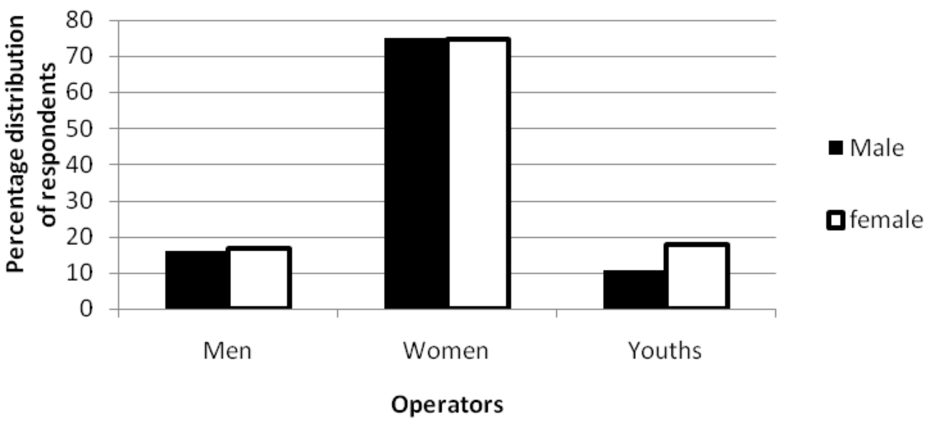

Fig 1: Distribution of Respondents According to Who Prepare food and water for labour in cassava production

Both male and female respondents indicated that men have more access to and control of finance than women and youths (Figures 2 and 3). Youths are the most disadvantaged in these aspects. Butterwort, *et al,* (2008) also reports that men have more access to formal capital because they have collateral in the form of land and houses. Women, who lack ownership of these assets, rarely take formal loans.

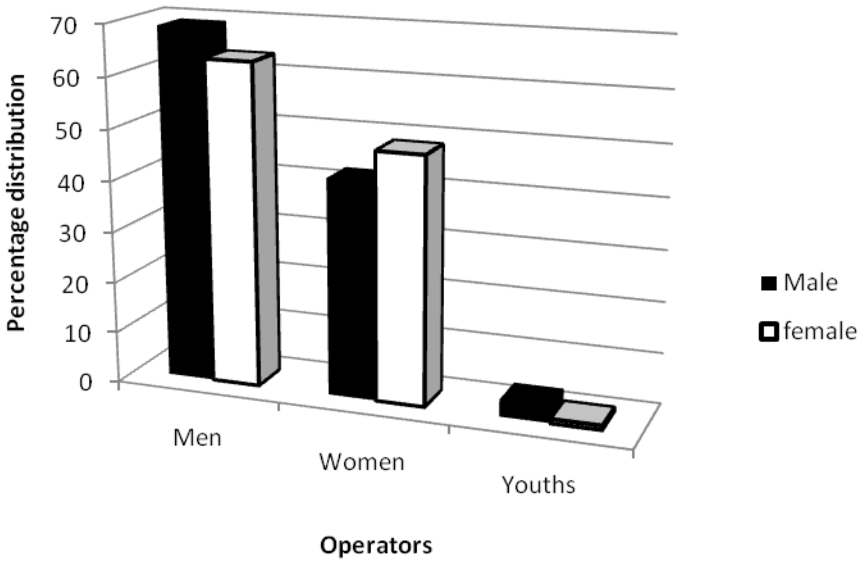

Fig 2: Distribution of Respondents According to their Access to finance

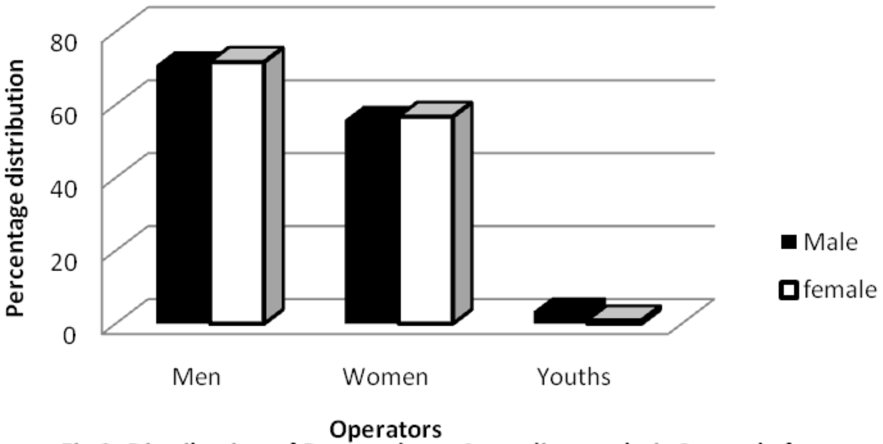

Fig 3: Distribution of Respondents According to their Control of finance

Conclusion

This study investigated gender roles in cassava production in Imo State, Nigeria. Men, women and youths played complementary roles in various operations involved in cassava production. While men dominated in heavy labour operations such as land clearing and tillage, women dominated in other operations like planting, weeding, harvesting and preparing food for farm use. Youths rarely had access to and control of finances for cassava production. In line with the finding of this study, gender gaps in cassava production exist in the study area. In order to address these gaps, male and female cassava farmers in the area should be allowed unrestricted access to productive resources as a way of exploiting their potentials in cassava production through the establishment of gender based cassava development programmes. Policy issues targeted at increasing cassava production in the state should advocate for more involvement of the males in and increased access to and control of finance by youths.

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Assessment of Gender Participation in Modern Broiler and Layer Poultry Production Management Practices in Abia State, Nigeria

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Abstract
This study assessed gender participation in modern broiler and layer poultry production management practices in Abia State, Nigeria. Specifically, the study identified constraints militating against gender participation in modern broiler and layer production management practices in the study area. A two-stage sampling technique was used in selecting sixty (60) poultry enterprises made up of thirty (30) modern broiler enterprises and thirty (30) modern layer poultry enterprises drawn from six (6) Local Government Areas across the three (3) Agricultural Zones of Abia State. Data for the study were collected through primary source using questionnaire, and analyzed with descriptive statistics. The results of the descriptive statistics showed that male participated more in the following poultry management activities: vaccination schedule, provision of light, marketing/sales and carcass disposal, while female participated more in these poultry management practices: drug administration, procurement, disinfection/sanitation, nutrition, brooding and record keeping. The three major constraints militating against gender participation in modern broiler and layer practices in the study area were: inadequate information, high cost of modern poultry equipment and lack of technical know-how. Hence, government through its relevant agencies should enlighten the masses on modern management practices in poultry production, to enhance gender participation.
Keywords: Gender participation, broiler and layer production and management practices

Introduction
The poultry industry plays significant role in the development of Nigeria economy constituting a major source of livelihood, income and helps in bridging the dietary protein deficiency prevailing in the country. (Abimbola *et al.,* 2014). Nigeria poultry industry fulfills a wide range of functions such as the provision of meat and eggs, food for special festivals, chicken for traditional ceremonies a source of pest control and petty cash, while requiring minimal external inputs, minimal human attention and causing minimal disruption to the environment (Adeyemi, *et al.,* 2012). Over the past decades awareness of gender issues in development has steadily increased (Rahman, *et al.,* 2007). There is a large and growing literature concerned with gender-based distributional issues and the economic activities of rural women. In poultry management, there is a growing recognition of the contribution of women in poultry production. Although there are several poultry enterprises in different agricultural zones of Abia State, there is dearth of information on gender participation in modern broiler and layer poultry production management practices in the study area. Hence, this study analyzed gender participation in modern layers and broilers poultry production management practices in Abia State, Nigeria with a view to fostering sustainable strategies for enhancing food security and livelihoods in Nigeria through gender mainstreaming.

Methodology
The study was carried out in Abia State, Nigeria. The state covers an area of about 5,243.7sq.km which is approximately 5.8 percent of the total land area of Nigeria. Its capital is Umuahia and

Aba is its major commercial city. Abia State lies within latitudes 4°40' and 6°14' north, and longitude 7°10' and 8° east. The indigenous ethnic group is Igbo. It has seventeen (17) Local Government Areas. The people of the state are enterprising. Modern poultry is practiced by a good number of people. Other agricultural products produced in the state include: cassava, yam, cocoa, palm oil and vegetables. Two stage sampling technique was used in the study. In the first, two Local Government Areas (LGAs) were purposively selected from each of the three Agricultural Zone of Abia state base on the preponderance of poultry enterprises. In the second stage, five modern broiler and five modern layer poultry enterprises were purposively selected from each of the six selected LGA. This brought the sample size to sixty poultry enterprises comprising thirty modern broiler and thirty modern layer poultry enterprises. Data for the study were sourced primarily using questionnaire. Data collected were analyzed with descriptive statistics such as mean, frequency and percentage.

Results and Discussion

Gender Participation in Management Practices of Modern Broiler and Layer Poultry Enterprises

The result of gender participation in management practices of modern broiler and layer poultry enterprises is as presented in Table 1.

Table 1: Gender participation in management practices of modern broiler and layer poultry enterprises

Management Practices	Male Mean Participation	Female Mean Participation	Remarks
Vaccination	3.71	3.57	Male dominated
Drug administration	3.46	3.83	Female dominated
Chick procurement	3.94	4.17	Female dominated
Provision of light	4.69	4.37	Male dominated
Disinfection/sanitation	3.71	3.94	Female dominated
Nutrition/feeding	4.31	4.93	Female dominated
Marketing/sales	4.00	3.87	Male dominated
Brooding	3.37	3.51	Female dominated
Record keeping	2.80	2.97	Female dominated
Carcass disposal	2.66	2.23	Male dominated

Source: Field Survey Data, 2017

The result on assessment of gender participation in management practices of modern broiler and layer poultry enterprises on Table 1 indicated that there was male dominance in the following poultry management activities: vaccination, provision of light, marketing/sales and carcass disposal while female participated more in these poultry management practices: drug administration, chick procurement, disinfection/sanitation, nutrition/feeding, brooding and record keeping. However, Okoh, Rahman and Ibrahim (2010) observed that males participated more on management activities such as vaccination, administration of drugs, debeaking and chick procurement while females were more engaged in daily routine activities like cleaning of pens, provision of water and sorting of eggs.

Constraints militating against gender participation in modern broiler and layer poultry enterprises in the study area

The result of the descriptive statistics on the constraints militating against gender participation in modern broiler and layer poultry enterprises in the study area is shown in Table 2 below

Table 2: Constraints militating against gender participation in modern broiler and layer poultry enterprises

Constraints	Mean	Rank
Lack of technical know-how	3.81	3rd
Insufficient capital	3.79	4th
Inadequate information on modern poultry management practices	4.70	1st
High cost of modern poultry equipment	3.96	2nd
Low access to credit	3.61	5th

Source: Field Survey Data, 2017

The result on Table 2 above showed that the constraints militating against gender participation in modern broiler and layer poultry enterprises in their descending order of importance were: inadequate information on modern poultry management practices, high cost of modern poultry equipment, lack of technical know-how, insufficient capital and low access to credit.

Conclusion

This study have shown that both male are female participate in modern broiler and layer poultry management practices, though female dominated activities tend to be more than their male counterparts. It is thus recommended that government through its relevant agencies should enlighten the masses on modern management practices in poultry production, to enhance gender participation. Also government should subsidize modern poultry equipment to make it affordable to poultry entrepreneurs.

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Effect Of Cassava Traditional Salad Commercialization on the Living Standards of Women Farmers in Bende Local Government Area

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Abstract
The survey was conducted to ascertain effect of cassava traditional salad sales on the living standards of women farmers in Bende Local Government Area, Abia State towards increasing food production and cassava curb poverty, examine the socio-economic characteristics of farmers engaged in processing and sale of the cassava traditional salad, compare difference between their incomes before and after embarking on the processing business, as well as identifying the constraints of the producers/traders during and after processing and sales of the cassava traditional salad business. The analytical technique used to achieve the objective of the study was Paired Samples Test and descriptive statistics (frequency, percentages and mean). The result showed that the dominant respondents were within the age range of 45 - 55 years which accounted for 42% and 41%. The mean incomes of the cassava traditional salad producers before they started the trading business were ₦74,435.43 while their incomes after the processed cassava traditional salad sales were ₦91,435.43, with a difference of ₦23,435.43. This means that the incomes of the respondents are higher than their incomes before their cassava traditional processing trade. The research study showed that the major constraint of the respondents was inadequate cassava traditional salad value addition facilities, lack of funds and storage facilities, and incessant electricity supply. It was recommended that Government should increase the fund allocation to the National Root Crops Research Institute, Umudike for provision of logistics for Extension Service Programmes, to increase food production and sustainability in rural development. Extension delivery on mechanized processing of cassava into traditional salad should be embarked on by the National Root Crops Research Institute, to encourage more rural women farmers. There is crucial need to train and employ more agricultural engineers in the Agricultural Sectors, including National Root Crops Research Institute to fabricate root and tuber crops processing machines for increased value added products, economic empowerment and to improve the livelihood of the rural women in Nigeria.

Introduction
The level of unemployment, poverty, hunger and hardship, in developing countries is still on the increase despite global advances in agricultural Technologies and entrepreneurial development. The business of processing of cassava into traditional salad for sale is one of the major sources of income of the farmers in Bende Local Government Area of Abia State because the area has a vast and fertile land for cassava production, as well as the cassava traditional salad producers and traders. Agro-business incomes account for progress and development towards poverty reduction in a country. Nigeria is the largest producer of cassava in the world with an annual output of 45 million metric tons, (F.A.O., 2017). Cassava Traditional Salad popularly known as "Agworoagwo Nsisa" in Bende Local Government Area of Abia State is taken as food. Cassava value added product is revenue yielding and provides employment opportunities for the jobless. Also, it enhances foreign exchange earnings in Nigeria (Aniedu, 2014). Cassava is peeled, washed, cut to size, cooked, sliced, fermented, sun-dried and prepared as traditional salad for

eating. The cooked cassava can be manually or mechanically sliced or processed into "Nsisa" used for preparing the traditional salad in Bende Local Government Area, (Oti, 2012). Due to the fact that cassava tuber crop is a vital source of food, rich in vitamins and highly medicinal, it becomes imperative to give adequate attention towards encouraging the cassava traditional salad value addition technologies producers. Majority of the respondents (55%) engaged in sales of cassava processing traditional salad were full-time farmers. The rest were either part-time farmers or combined farming with petty trading. Since the-women farmers in the area depend largely on traditional agriculture for subsistence, any meaningful effort for their effective participation and improved living standards must be directed toward improving their production, processing and storage technology. In order to bring rural women to the limelight of sustainable agricultural development, there is urgent need to encourage the women farmers in the cassava processing business. Therefore, the essence of this research study is to empower the producers on the one hand. and to increase food production as well as food security and sustainability on the other hand.

Methodology

The research study was conducted in four Communities in Bende Local Government Area of Abia State namely: Uzuakoli, Nkpa, Ozuitem and Akoli-Imenyi Communities. Bende is one of the seventeen Local Government Areas in Abia State, South-eastern Zone of Nigeria. There are among the major cassava processing traditional salad communities in Bende Local Government Area of Abia State. A survey on the involvement of women in processing of cassava into traditional salad, as a strategy to boost food production for the new century was conducted among the four communities. All the four communities were purposively selected; and questionnaires were distributed to a total of (20 x 5) 100 respondents as the sample size, from the area under study. The services of Agricultural Development Programme (ADP) Extension Agent employed to supervise each of the selected communities and the list of cassava processing traditional salad traders were obtained. The analytical technique used to achieve the objectives was descriptive statistics (percentages, mean and frequency) and Paired Samples Test.

Results and Discussion

The Socio-economic status and general living standard of the respondents were assessed under the following; age, occupation, marital status, education, income, type of housing, type of building, source of drinking water and source of lighting. The results of the analysis for the socio-economic profile and Paired samples test incomes of the respondents (Before) and their incomes (After) sales of the cassava traditional salad. are presented in the Tables 1 - 3 respectively.

Socio-Economic Status of the Respondents before and after Processing and Sales of Cassava Traditional Salad in the Study Area

Age of respondents

The dominant age range was 46 - 55 years, which accounted for 42% and 41% before and after the sales respectively. The implication is that majority of the respondents belong to the adult aged group that are known for their creativeness, productiveness, mental alertness and effective reasoning more their younger farmers (Amadi,, 2011).

Occupation

Up to 55% were full-time farmers after the business, while their counterparts' part-time farmers represented 53% (before the business). This explains why the part-time farmers tend to be less amenable to income diversification than their full-time counterparts. (Okoye, 2011).

Marital status

Up to 80% of the respondents are married. This implied that majority of the married women dominated this group. This is in line with the proposition that women play vital role in food production, processing and marketing in Nigeria (Asumugha, 2014).

Education

Also, the number of respondents who had secondary education increased from 17% to 21%. According to Okoye (2011), educated farmers are more receptive to changes while farmers with little or no education are conservative to accept changes and innovations. The percentage of respondents with non-formal education (35% and 20%) confirms their perception.

Income The respondents between the age range of 46 – 55 and 56 - 65 years recorded the highest incomes (N500,000 - N690,999 and N600,000 – N790,999) respectively. This showed that cassava traditional salad trade is income generating, profitable and job creating, thereby improved the respondents' livelihood in the study area.

General Living Standard of the Respondents
The variables that recorded the highest scores marked asterisks showed that there were remarkable improvement in the general living standards of the cassava traditional salad women farmers in the study area.

Type of Housing: This showed that 30% and 27% who emerged majority of the respondents lived in flats without water closet, followed by 44% and 42% who lived in flats with water closet before and after the cassava traditional salad sales respectively. It is glaring that there was a clear distinction between the respondents general standard of living after the business in terms of housing , than the type of house they were occupying before they started the agro-business.
Types of Building Materials: Up to 20% and 42% of the respondents lived in buildings constructed with block with/zinc roof while 18% and 25% of the respondents resided in houses with thatched roof. While the minority of the respondents experienced changes in the type of building materials they had; there is no doubt that the cassava traditional salad value addition sales had positive effect on the type of building materials respondents' houses were constructed with.
Sources of Drinking Water: As an important measure of standard of living, source of drinking water was assessed. About 30% of the trainees get drinking water from tap water before the training, while the number increased to 37% after the training. Also, there was an increase in the number of the respondents who use bore-hole from 37% to 40%. The use of well and stream/spring water was drastically reduced. There is obviously marked difference between the respondents source of drinking water both before and after the business..
Health Service Provider: It was observed that the majority of the respondents (35% as against 29%) receive medical treatments from the Clinic/Hospital/Health Centre, followed by healing through prayers by their Churches which recorded 40% as against 9% before the cassava traditional salad sales. There was drastic percentage reduction in patronizing and consulting the traditional healers/native doctors by the respondents from 30% to 11%, to attend to their health needs. Hence there was positive change observed between the respondents health service provider before and after the cassava traditional salad sales.
Source of Lighting: Majority of the respondents which accounted for 30% as against 45%, and 28% as against 33%; have electricity and kerosene lamps as their source of lighting after the sales respectively. Based on observations, it is obvious that the cassava traditional salad sales influenced the living standard of the rural women cassava farmers positively since their living standards registered a remarkable improvement.

Paired Samples Test of Income of Respondents Before and After Commercialization
This showed that the mean incomes of the cassava traditional salad producers before they started the trading business were ₦74,435.43 while their incomes after the processed cassava traditional salad sales were ₦91,435.43, with a difference of ₦23,435.43. This means that the incomes of the respondents are higher than their incomes before their cassava traditional processing trade.

Conclusion

The mean income difference, ₦23,435.43 of the respondents after the processing and sales of the cassava traditional salad indicated that the business is viable. This implies that the income of the women cassava traditional salad producers were higher than their incomes before they embarked on the business. The research study showed that the major constraints of the respondents were lack of funds and inadequate facilities for cassava value added products. It was therefore recommended that both the women cassava farmers and cassava traditional salad producers should be encouraged to enable them access to agricultural information and benefit from agricultural programmes of the government. Government intervention to release more funds to National Root Crops Research Institute, Umudike for training of the rural women on mechanized cassava traditional salad value added products is very imperative. This will enable them to move from the low to high level mechanized production of cassava traditional salad, not only to increase their incomes but also to enhance foreign exchange earnings. More agricultural engineers should be employed and trained in the Agricultural Sectors, including National Root Crops Research Institute to fabricate root and tuber crops processing machines for increased value added products, economic empowerment and to improve the livelihood of the rural women in Nigeria.

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Table 1: Socio-Economic Characteristics of the Respondents

Variables (n=100)	Respondents Gen. Living Std. After Cassava Traditional Salad (Sales)		Respondents (General Living Std. Before Cassava Traditional Salad (Sales)	
	Frequency	Percentage	Frequency	Percentage
Age (Years)				
26-35	15	15.00	20	20.00
36-45	12	12.00	30	30.00
46-55	42	42.00*	40	40.00
56-65	31	31.00*	10	10.00
Occupation				
Full time farming	55	55.00*	53	53.00
Part time farming	45	45.00	47	47.00
Marital Status				
Married	80	80.00*	70	70.00*
Single	20	20.00	30	30.00
Education (years)				
Formal Education	11	11.00	12	12.00
Primary Education	18	18.00	30	30.00
Secondary Education	41	41.00*	48	18.00*
Tertiary Education	30	30.00	10	10.00*
Income (Naira)				
300,000 – 490,999	10	10.00	25	25.00
400,000 – 590,999	20	20.00	20	19.00
500,000 - 690,999	30	30.00*	20	21.00
600,000 – 790,999	40	40.00*	35	35’00

Source: Field Survey (2017)

Table 2: Distribution of General Living Standard (GLS) of the Respondents

Variables (n=100)	Respondents GLS before Cassava Traditional Salad (Sales)		Respondents GLS after Cassava Traditional Salad (Sales)	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Type of housing				
Single Detached Room	10	10.00	12	12.00
Room and Parlor	20	20.00	22	22.00
Flat without water closet	37	27.00	28	28.00*
Flat with water closet	33	33.00	38	38.00*
Type of Building Material				
Mud with thatched roof	40	40.00	17	17.00
Mud with zinc roof	32	32.00	33	33.00*
Block with thatched roof	10	10.00	12	12.00
Block with zinc roof	18	18.00	38s	38.00*
Source of Drinking water				
Tap water	30	30.00	37	37.00*
Bore hole	37	37.00	40	40.00*
Well	18	18.00	13	13.00
Stream/spring	15	15.00	10	10.00
Health Service provider				
Clinic/ Hospital/ Health Centre	40	40.00	47	47.00*
Patent medicine dealer/chemist shop	32	32.00	29	29.00
Traditional healers/Native Doctors	20	20.00	5	5.00*
Church	8	8.00	19	19.00*
Source of Lighting				
Electricity	30	30.00	45	45.00*
Kerosene Lamp	28	28.00	33	33.00*
Candle	24	24.00	12	12.00
Oil Lamp	18	18.00	10	10.00*

Source: Field Survey (2017)

Table 3: Paired Samples Test Incomes of Respondents (Before) and Incomes of the Respondents (After)

Variables	**Mean**	**Paired Mean**	**95% Confidence Interval of the Difference**	
			Lower	**Upper**
Respondents' Incomes After their Trading period	₦91,435.43,*	₦23,435.43*	8,231.04	10,732.52
Incomes Before their Trading period	₦74,435.43*			

*P≤0.05 Source: Computed from field survey (2017)

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Analysis of Gender Differences in Agricultural Inputs Use among Cassava Farmers in Anambra State, Nigeria

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Abstract
This study was designed to estimate and compare the level of the use of agricultural inputs among cassava farmers in Anambra State by gender. The State lies within the $6^{o}13'$ and 7^{o} 9' North and longitudes $7^{o}49'$ and $7^{o}57'$ East and on a plain under 200m above sea level. A multi-Stage random sampling technique was used in selecting 180 farmers (equal number of female and male) from three out of four Agricultural Zones of the State. Primary data were used for this study and were analyzed using descriptive statistics (mean, frequency and percentage) and rated using Likert rating scale. The result of the likert showed that male cassava farmers control and use high level of inputs than their female counterparts. This study therefore recommends a policy that will aim at gender equality in the control and use of inputs for cassava production by gender.

Introduction
The cassava (*Manihot esculenta*) plant is a perennial woody shrub that grows from about one to three meters in height with palmate leaves. It was introduced to Africa by the Portuguese during the late 16^{th} century (Nweke, 1994). The crop is friendly to different environmental conditions and well suitable for integration into the farming systems and socioeconomic conditions of Africa (Nweke, 1996a). The crop's ability to provide a stable food base is a function of its flexibility in terms of planting and harvesting strategies. (Government of Ghana, 1996). According to Onyemauwa (2010), cassava has the potential to increase farm incomes, reduce rural and urban poverty and help close the food gap. As a cash crop, cassava generates cash income for the largest number of households, in comparison with other staples, contributing positively to poverty alleviation (Obisesan, 2012). Reports have shown that a higher proportion of cassava farmers, in Nigeria get a higher income from its production than they get from most other major staple (Ezeibe et al., 2015). Nigeria has remained the global leader in cassava production with an annual production of 35 million metric tonnes (Food and Agriculture Organization, 2011). Nigeria is regarded as the largest producer of cassava but the output per hectare remains one of the lowest in the world principally due to poor technological development and use rudimentary farm inputs. (Ogundari, 2010). However, because of economic diversification towards agriculture, modern agricultural inputs started to emerge. Anaglo, (2014) noted that farmer capacity to employ improved technology and investment depends on their access and use of productive resources. Both men and women contribute significantly to agricultural production yet their access to agricultural resources differ (Deere and Doss, 2006). For instant women face several challenges most importantly cultural restrictions in accessing inputs than men (FAO, 2010). Based on this information therefore, the focus of this paper is to estimate the gender differential access to farm inputs by cassava farmers.

Methodology
Study Area
This study was conducted in Anambra State, in South Eastern Nigeria, which comprises of 21 Local Government Areas (LGAs) with four Agricultural zones (ASADEP, 2003). The area lies within the $6^{o}13'$ and 7^{o} 9' North and longitudes $7^{o}49'$ and $7^{o}57'$ East (Nfor, 2006). The area lies

mainly on plains under 200m above sea level (ASADEP, 2003). It has tropical rain forest vegetation, humid climate and a rainfall of between 152mm- 203mm. The main crops of the State are roots, tubers, cereals and tree crops. The State has comparative resource advantage for production of cassava than most of the Southeastern States (ASADEP, 2003).

Sample Selection

Sample Selection

A multi-stage sampling technique was used in choosing the samples. Three agricultural zones (Aguata, Anambra and Awka) were randomly selected for the study. Secondly from the zones, one extension block each was randomly selected. Thirdly, two circles were randomly selected from each of the blocks. Furthermore, one village was randomly selected from each of the circles. Ten (30) respondents (that is 15 males and 15 females) were randomly selected from each of the villages. Thus a total of 180 cassava farmers were selected for the study.

Data Collection

Preliminary visits were carried out to the three agricultural Zones before the commencement of the actual data collection. The visit was an aid for the familiarization of the researchers with the study locations, resident agricultural extension agents, key informants and field guides. Data were collected using structured questionnaires and interview schedule. Data collection covered the socio-economic characteristics of the farmers, labour, farm size, herbicides application, capital, improved cassava stem, fertilizer application.

Data Analysis

Descriptive statistics (such as mean, frequency, and percentages) was used to derive socio-economic characteristics of the farmers while likert scale on a 3-point with a bench mark of 2 such that high (3), medium (2) and low (1). Note that any technologies rated 2.5 to 3 is regarded as high, from 2 to 2.49 is medium and from 1 to 1.49 is low. The likert-scale is stated as follow:

likert scale model:

$\overline{X}s = \frac{\sum FN}{N_r}$

Where

$\overline{X}s$ = mean score

$\sum$ = summation sign

F = frequency

N = likert nominal value

Nr = number of respondents

Results and Discussion

Socio-Economic Characteristics of the Respondent

The distribution of respondents according to socio-economic characteristics presented in Table1 indicated that the farmers (both male and female) were adults but still active in the business of cassava farming. The result confirmed that adult male farmers were the majority (76.11%) that had access to inputs for cassava production compared with their female (57.78%) counterparts. This is an indication that female farmers are still taking a lead in cassava enterprise than male farmers. The result for the level of education shows that male farmers were more educated than their female counterparts and is an indication that male farmers will have more knowledge on where to source and use the inputs. The female farmers have more experience (mean level of 23 years) on cassava production than the male (20 years). Perhaps female are virtually involved in all the scopes of its production (production, processing and marketing). The mean level of farm size for male farmers (1.8ha) and that of female farmers (1.2ha) is an indication that both of the farmer groups are small scale farmers (Onyebinama, 2004) but yet male farmers control the land more than their female counterparts.

Table1: Distribution of respondents according to socio-economic characteristics

	Male		Female	
Age (Years)	Frequency	Percentage	Frequency	Percentage
18-35	26	14.44	20	11.11
36-53	11	6.11	41	22.78
54-71	137	76.11	104	57.78
72-89	6	3.33	15	8.33
Mean	48		49	
Educational Status				
Primary School	68	37.80	58	32.22
Secondary School	56	31,11	69	38.33
Tertiary	34	18.90	23	12.80
None	22	12.22	30	16.70
Farming Exp (yrs)				
1-10	30	16.70	33	18.33
11-20	78	43.33	46	25.60
21-30	53	29.44	50	27.80
31-40	12	6.70	41	22.80
41-50	7	3.90	10	5.60
Mean	20	11.11	23	
Farm Size (ha)				
0.1-2.0	132	73.33	162	90.00
2.1-4.0	43	23.89	14	7.78
4.1-5.0	5	2.78	4	2.22
Mean	1.8		1.2	

Source: Survey Data 2017

Table 2: Distribution of respondents according to the level of inputs assessment by gender

	Male Farmers		**Female Farmers**	
Agric. Inputs	**Level Of Usage**	**Rating**	**Level Of Usage**	**Rating**
Herbicide	2.1	Medium	2.8	High
Fertilizer	2.0	Medium	2.9	High
Capital	2.7	High	1.7	low
Labour	2.5	High	1.9	Low
Land	2.6	High	1.5	Low
Improved Cassava Variety	1.7	Low	2.8	High

Source: Survey Data 2017

Table 2 shows the level of inputs assessment by male and female farmers in Anambra State. The result shows that female cassava farmers have high level of use of herbicides than male farmers. Perhaps female farmers use the herbicides as assistance for weed control on cassava farm than the male farmers who predominantly engage in land preparation. This agreed with the finding of Food and Agriculture Organization, (2009) who reported that women specialized on weeding and other farm maintenance. The result also shows that female farmers have high level of use of fertilizer than their male counterparts. Maybe the level of usage would be as a result of experience from training (women empowerment training) that productivity of cassava could be increased with the application of right quantity of fertilizer. This agrees with the report of Nwaru (2004) who noted that experience is knowledge and skill gained by contact with facts and events. Male cassava farmers have high control/use of capital than their female counterparts especially in a household where male farmers are the household head. Perhaps male farmers engage in economic activities that generate them more income than their female counterparts. This agrees with the finding of Eftila et al., (2013) who noted that female farmers are limited with revenues and therefore restrict from investing in new technologies.

Male farmers usually use hired labour for their farming activities than their female counterparts who normally use self-labour and family labour maybe due limited fund female farmers control in their family. This agrees with Mgbakor and Nwamba, (2013) who that the major challenge faced by the women is inadequate labour. The result for the use of land by male and female farmers shows that male farmers have high level of land usage than their female counterpart. This is an indication that female farmers especially in male headed household have less right over the use of land for any economic activity than male perhaps due to the culture. This agrees with FAO, (2010) who stated that globally women scarcely own land due to norms and custom. From the result, female cassava farmers have high level of the use of improved cassava varieties than their male counterparts. This would be perhaps attributed to the early adoption ability by female farmers than their male counterparts who will always adopt crops they think are of economic relevant. This would be attributed to the fact that more than 50% of women are involved in cassava production than men (Mgbakor and Nwamba, 2013).

Conclusion

From the result male farmers have high level of controls/uses over capital, labour and land, medium level over herbicide and fertilizer, and low level over improved cassava variety while female farmers have high level over the controls/uses of herbicides, fertilizer and improved cassava variety and low over the control/use of capital, labour and land. The study concludes that male farmers have high level of inputs control/use in the production of cassava despite that female farmers are much involved in cassava production than male. Therefore this study recommends that all the resources meant for cassava production should be made available to all categories of farmers for sustainability and high productivity of cassava.

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Gender Roles in Forest and Tree Products Employment and Poverty Reduction in Rural Areas of Delta State, Nigeria

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Abstract
The study was conducted to investigate gender roles in forest and tree products (FTPs) employment and poverty reduction in rural areas of Delta State, Nigeria. Purpose was to attract the attention of policy makers and stakeholders that aside farming there are other sectors of the rural economy that can help address food problems, and poverty when given attention. Multistage sampling techniques were used to select 360 rural household respondents. Data was sourced from primary and secondary sources. Data was analysed using descriptive statistics, t-test distribution and Foster, Greer and Thorbecke model of poverty analysis. FTPs income helped to reduce poverty among the rural households. This is as a result of the fact that when FTPs income was excluded from household total income, incidence, gap, and severity of poverty increased from 0.4870, 0.1522 and 0.0476 respectively to 0.7903, 0.3203 and 0.0810 respectively. Females were more actively involved in FTPs employment than their male counterparts (P<0.05). While adult females and children exploited FTPs for subsistence purpose, the adult males reasons were found to be commercial. Recommendations include integration of FTPs into National Accounting System, allowing women and men to participate in policy formulation and implementations; policies should shift towards participatory approach to FTPs activities and creating an enabling environment in rural areas through the provision of basic amenities.

Keywords** **Gender** **Forest and Tree** **Products** **Poverty

Introduction
Within the framework of off-farm economy in Nigeria, the rural people especially the poor are dependent on forest and tree products (FTPs) for most of their livelihood. Forest and tree products are derived from natural forest, planted forests and trees outside forest. Trees outside forest include isolated trees in landscape, windbreaks, shelter belts, trees along roads and rivers, trees in agricultural systems and trees in urban environment (FAO, 2013). According to Ahmed (2000), FTPs are products from forest and all other parts or produce of trees and plants including climbers, grasses and creepers. They also include produce from animals when found or brought from a forest, peat surface soil and minerals. In this study, FTPs are defined as products derived from natural forest, planted forest (including plantations and orchards) and trees outside forest. FTPs are made up of wood and non-wood products. The wood products are mainly timber, firewood and charcoal. Timber is used mainly as building materials, furniture, matches, utensils, books, newspapers, toilet tissues and fuelwood among others (FAO, 2013). On the other hand non-wood forest products (NWFPs) consist of goods of biological origin (FAO, 2013). They include fruits, nuts, mushrooms, beverage, wine, clean water, medicinal plants, latex, rubber, gums, and resins, cloth, jute fibres, bask fibres, chewing sticks, tooth cleaners, sponges, decorative bead, oil, barks, bark and lac, natural varnish, tanning extracts, fodder, honey, bee wax, milk cocoons and forest games (Nwandu, 2015). For the purpose of this study, the economic and environmental services provided by forest and trees, for example carbon sequestration, soil fertility and soil protection, watershed protection, windbreak uses or general aesthetic and spiritual values are not included. FTPs contribute significantly to rural household consumption, income and employment. FTPs based employment provide opportunities in many rural areas. These FTPs based employments often require low establishment costs and are

characterized by easy and open market access which tend to make them accessible to rural households and the poor (Rahut; Behera and Akhter, 2016). It may be full or seasonal employment. Most of these enterprises are very small and household based enterprises. There is increasing recognition within the field of forestry that gender issues are important. The focus has shifted recently to women and men's access to forest resources, as a means of improving livelihoods for the resource poor and sustainable forest management locally and globally. Men usually focus on the management of timber while many rural women spend many hours each day collecting NTFPs especially fuelwood which they depend on for cooking their meals (Moss and Swan, 2013). It is necessary to explore and develop other sectors of the rural economy aside agriculture. The expectation is to help broaden the choice of policy alternatives in solving food problems, reduce poverty and income inequalities in the rural areas. An important but neglected sector in the rural economy is the FTPs. Apart from the exploitation of FTPs like timber which is well documented, quantified and generally accessible to national statistics and calculations, information on the informal activities of the non-timber FTPs which is engaged in by the vast majority of the rural households are not generally known. If known, they tend to be descriptive rather than quantitative and are discounted in national statistics. Moss and Swan (2013) stated that women contribute to forest management. Yet these contributions have been under-recognised as there are significant income disparities between men and women in forestry performing the same task. Women are supposed to be involved in policy making and management. However, in practice, the reverse is usually the case. When State Department of Forestry (SDF) seek local advice they turn as men to men in the household or village. These knowledge gaps identified are not being targeted but are necessary for policy. This study therefore examined these issues and made some recommendations.

The broad objective of the study is to investigate gender roles in forest and tree products employment and poverty reduction in rural areas of Delta State, Nigeria.

Methodology

The study area was Delta State, Nigeria. The rural population is engaged in one form of farming or the other. However, apart from farming, majority of the rural population were engaged in off-farm, non-agricultural employment.

Sample and Sampling Procedure

A multistage sampling technique was used for the study. The first stage was the purposive selection from the 3 Agricultural Zones, 2 local government areas each giving a total of 6 LGAs used for the study. The second stage was selection through random sampling, 4 rural villages each from the 24 villages. The final stage of the sampling was the selection of 15 rural households each from the 24 villages giving a total of 360 households respondents used for the study.

Data Collection

Data was gathered from both primary and secondary sources. The primary data were generated by use of sets of structured and semi-structured questionnaires. In all 340 questionnaires was successfully completed and was used for the analyses. The semi-structured questionnaire was also used to collect rural household consumption data on the different economic activities of the households. Data were collected on daily basis and collated into weeks, months and finally annually. At the end of the exercise, 179 rural household respondents successfully completed the exercises on income and consumption and were used for analyses. Because of the seasonal availability of FTPs, this exercise was carried out for a year (October 2014 to September 2015).

Data Analysis: Data was analysed by the use of descriptive statistics such as frequency distribution, percentages, means and standard deviations. The economic valuation techniques of market price-based valuation method such as Benefit Transfer (BT) method were also used. Hypotheses were tested using t-test distribution. Poverty was analysed using Foster, Greer and Thorbeck (FGT) Model

Results and Discussion

Demographic characteristics of FTPs-dependent rural households

Table 1 shows the common occupations engaged in by the rural household respondents in the study area. The main occupations were agriculture and FTPs activities. Other occupations engaged in by the rural households include business with the highest proportion of 35.6%. This was followed by agricultural labour and artisans. The public and private occupations were the least sector with 19.4%. Usually, FTPs activities are usually grouped with agriculture but in this study they were separated to find out the contribution of each sector to the rural household economy. While some members of the household engage in farm work others are busy with FTPs activities

Table 1: Demographic characteristics of rural household *(n =340)*

Age (Years)	**Frequency**
20 – 30	19 (5.6) *
31 – 40	90 (26.5)
41 – 50	101(29.7)
51 – 60	80 (23.5)
61 – 70	43 (12.6)
Marital Status	
Married	272 (80.0)
Widowed	36 (10.6)
Single	4 (1.2)
Divorced	28 (8.2)
House Hold Size	
Less than 7 persons	13 (3.8)
7 – 11 persons	176 (51.8)
12 – 14 persons	106 (31.2)
Greater than 14	40 (11.8)
No response	5 (1.4)
Educational Qualification	
Post- Secondary Education	29 (8.6)
Secondary Education	76 (22.4)
Primary Education	80 (23.5)
No Formal Education	155 (45.6)
Occupation	
Main Occupation	
Agriculture	340 (100)
FTPs	340 (100)
Other occupations	
Artisan	75 (22.1)
Business	121 (35.6)
Agricultural Labour	78 (22.9)
Public and private sector employee	66 (19.4)

Source: Field Survey 2014/2015; Figures in parentheses are percentages of respondents

Valuation of FTPs Contribution to rural Household Income and Consumption

Table 2: Contributions of different economic activities to rural household consumption

S/N	**Economic Activity**	**Contribution to Total Consumption (N)**	**Percentage (%) Contribution to Total Consumption**
1.	FTPs	21,720,828	31.9
2.	Agriculture	17,022,592	25.0
3.	Agricultural labour	3,064,066	4.5
4.	Business	6,264,314	9.2
5.	Public and private sector	4,017,332	5.9
6.	Artisan	5,99,1952	8.8
7.	Transfer	10,009,284	14.7
	Total	68,090,368.00	**100.0**

Source: Field Survey 2014/2015

Measurement and Analysis of Poverty among FTPs-Dependent Rural Households

Table 3 shows that when relative poverty was measured with FTPs consumption income inclusive, the head count index was 0.4870 depicting that 48.70% of FTPs-dependent rural households were poor. The income-gap ratio or intensity of poverty was 0.1522. That is the poor individuals' income transfer requires about 15.22% to bring them to poverty line. The severity of poverty was 0.0476 which shows that 4.76% of the individuals suffer severe poverty. However, when relative poverty was measured without FTPs consumption income poverty increased tremendously. The head count index increased to 0.7903 throwing about 30.3% more individuals into poverty. The income-gap ratio widened to 0.3202 while the severity of poverty also rose to 0.0810.These findings have therefore revealed that although poverty pervades in rural households, FTPs income is an important source in reducing poverty in rural households as also observed by Muleng, et al (2012).

Table 3: Relative Poverty Indices With and Without FTPs Consumption

	H (α = 0)*	I(α = 1)*	FGT (α = 2)
1.	Poverty indices with FTPs consumption income		
	0.4870	0.1522	0.0476
2.	Poverty indices without FTPs consumption income		
	0.7903	0.3202	0.0810

Source: Field Survey 2014/2015
*H(**α** = 0) = Head count ratio, I(**α** = 1) = Income – gap ratio, FGT (**α** = 2) = severity of poverty.

Rural Household Members FTPs Employment Status

Table 4 Show that 87.6% of the rural household members were engaged in FTPs employment. The result also shows that almost all the members living in the household were involved in FTPs activities. However, the adult females with 96.0% were more involved in FTPs activities, followed by adult male with 93.03%. The children female (84.6%) and children male (83.3%) were also very much engaged in FTPs employment. On gender, the females with 87.85% were more involved in FTPs activities than their male counterparts with 86.3%. These findings were in line with that of Mulenga, Richardson and Tambo, 2012. Moss and Swan (2013) also stated that females are very much engaged in FTPs activities than their male counterparts. That while females are engaged in FTPs production, processing, marketing and management especially NTFPs, men usually focus on the management of timber.

Table 4: Rural household members FTPs employment status

Gender	Total number in sample	Number engaged in FTPs employment	Percentage (%)
Adult male	258	240	93.0
Children male *	593	494	83.3
Total male	**851**	**734**	**86.3**
Adult female	321	308	96.0
Children female *	790	668	84.6
Total female	**1111**	**976**	**87.9**
Total household members	**1962**	**1710**	**87.6**

Source: Field Survey 2014/2015
* Children are members of the household below the age of 17

Employment in FTPs as Affected by Gender

The gender compared was the male and female members of household involved in FTPs employment using the t-test analysis.

Table 9: T-Test Statistics of gender in relation to FTPs employment

	Mean	N	Std deviation	Std Error Mean	t-cal	df	Sig (2) tailed	Remark
Members involved in FTPs employment – Male	4.37	339	1.479	0.080				
Number of household members involved in FTPs employment – Female	5.47	339	1.741	0.095	9.184	338	0.00	S*

Source: Field Survey 2014/2015; * = Significant; Significant level = 0.05

The t-test analysis in table 9 shows a calculated t-value of 9.184 as compared to critical t-value of 1.96 at 0.05 level of significance. This indicates that the difference was significant. That is, there was difference in the male and female members of the household engaged in FTP employment. We can further conclude that the females were more engaged in FTPs employment than their male counterparts in the household. The hypothesis that gender was not affected by the total number of household members engaged in FTP employment was therefore rejected and the alternative accepted.

Conclusion

Results confirmed that poverty generally pervade in the rural areas. However, incomes from FTPs employment were found to help reduce poverty in the rural areas. Policies should shift towards participatory approach to FTPs activities. The present "top to bottom" approaches where policies and regulations about FTPs are passed from government agencies to the rural households usually alienate the rural households who are the end users. The result is a disconnect between the policy makers, policy implementers and end users. The rural household should be involved in any policy or regulation formulation and implementation. This will help them see such policies or regulations as their own and work hand in hand with government agencies to enforce and defend the policies.Similarly, at local levels giving females chance to fully participate in formulation and implementation matters concerning FTPs will improve conservation, extraction and utilization. As revealed by the findings of the study, females constitute majority of rural household members engaged in FTPs employment. Their views are needed to guide the formulation and implementation of FTPs policies and regulations. Education and enlightenment of rural households especially women who constitute majority in FTPs activities will go a long way in improving the quality and value of their products. The enlightenment can be on issues of production, processing, marketing and conservation among others. Methods can be through demonstration, discussions, meetings, exhibitions, television and radio programmes.

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Preference of Songs in Disseminating Maternal Health Care Messages among Rural Women in Imo State, Nigeria

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Abstract
The study assessed why rural women preferred songs as a channel of communicating maternal health messages in rural communities in Orlu Senatorial zone, Imo state, Nigeria. About 180 respondents were selected from villages, they were previously exposed to songs where health issues were incorporated. Data were collected with the help of semi- structured interview schedule. A 4-point Likert type scale was used to generate data and analyzed with mean scores in disseminating maternal health messages shows that non-technological in nature had a mean score of $\overline{(x = 3.42)}$*, messages presented life* $\overline{(x = 4.0)}$*, appealing effect* $\overline{(x = 3.14)}$*, cultural compatibility* $\overline{(x = 3.28)}$*, in built feedback mechanism* $\overline{(x = 3.43)}$*, attract people easily* $\overline{(x = 3.50)}$ *and minimum input* $\overline{(x = 2.67)}$*. Songs as a channel of disseminating maternal health messages was preferred by the women and the study records that policy makers should also incorporate folk media as one of the major channels in reaching rural women.*

Key words: Songs, Rural women and Maternal health

Introduction
Folk media is a broad concept representing a variety of forms that have differing communicative entertainment and educational potential. They vary from place to place, culture to culture and region to region (Mathiyazhagan 2005), but in all these forms the purpose remains the same, that is to inform, educate and entertain the audiences for generating awareness among them about development issues, including health and family welfare, rural development, agriculture and social aspects among others. With this, there exist varied level of acceptance and preference towards folk media, which in turn determine their applicability for development communication in a given development setting. This study is confined to a specific folk media (songs and dance). Poor health status, a wide range of controlled, uncontrolled, preventable and non-preventable diseases and inadequate health care services are considered a major deterrent to human, social and economic development in developing countries (Brass etal, 2007). Anasi (2012) investigated the dissemination and spread of health data in African and demonstrated that numerous African nations use distinctive techniques and channels to disperse health information to most communities. Besides utilizing normal speech, health are also conveyed as melodies, stories and talks (Anasi, 2012). Tsehay (2014) also explored that maternal health information sources of women residing in five villages in Ethiopia. The outcome of the study revealed that lack of knowledge perceived personal risk of health problems, and seeking a healthy life are the main the factors that motivate women to seek for information. Nwagwu and Ajama (2011) examine the health information needs, sources and information seeking behavior of people living in rural Nigeria. The study explained that the respondents relied on traditional sources for health information and visited health services when they are seriously sick. Omogor (2013) also conducted a similar study in Nigeria, the result revealed that town criers, market places, songs, traditional festivals, radio were vehicles of information that were used to set and distribute health information among themselves. A study conducted by Wolf and Bond (2002) affirms that

peer education tends to increase the behavioural change of adults and adolescent due to the similarities that may exist between the educator and the target. In Nigeria, these demographic similarities, along with trends towards the familiar, can be observed in effective communication. In the later parts of the 1940s where health communication to the Nigerian people by the government began, attempts at showing films clips and using innovative technology were not successful. It was only through the utilization of specially designed puppet shows and performance directed to the specific ethnic groups that the expected conduct and awareness level change happened (Onogor, 2013). The best communication strategy for developing countries is based on the idea of integrating with the community. (Ford *et. al.,* 2005) opine that that the adoption of participation, self-determination and the inclusion principle in the information delivery strategy has a fundamental way certain behavior is wrong and also further state that permeating people to deliver input on how health data is going to help them change both talking over different communication channels to be used and setting goals for desired change together provide such responsibilities. The study investigated, Women Preference of Songs in Disseminating Maternal Health Care Services, since that the closer a message is to the culture, expectations and lifestyles of the individual and the more integrated the advert campaign is with such characteristics, the more effective health information can be passed on and behavior change achieved.

Methodology

The study was conducted in Orlu Senatorial zone of Imo state. For the purpose of this study, three villages namely Nwangele, Orlu and Ideato North purposively selected in which traditional media shows (songs related to health issues) were performed regularly in a year previous to the investigation. Using the purposive randomly sampling method, a total of 180 viewers from the selected villages were selected. All the 180 viewers were found to be regular viewers of the traditional media. Data were collected with the help of semi-structured interview schedules. 4-point Likert type scales of strongly agree = 4, agree = 3, strongly disagree = 2 and disagree = 1 was used to generate data for the study. Data generated were analyzed using mean scores.

Results and Discussion

Table 1: Mean Preference of Songs in Communicating Health Care Messages among Rural Women in Imo State

Statement	Mean Score
Non- technological in nature	3.42
Messages are presented life	4.0
Have more appealing effect on target audience	3.14
Cultural compatibility	3.28
In built feedback mechanism	3.43
Minimum input, maximum output	2.67
Attracts people easily	3.50
Grand mean	3.38

Source: Field Survey, 2017

Results on Table 1, shows mean preference of songs in communicating health care services among rural women. From the result, non-technological in nature had a mean score of $(\overline{x} = 3.42)$. The implication is that no special skill is required in disseminating the information but only flexible and culturally rigid. Messages are present life $(\overline{x} = 4.0)$. According to agricultural extension concept, when messages are supported with visual aids it enhances their recollecting ability. Effect on target audience had a mean score of $(\overline{x} = 3.14)$. This is possible because it has been designed to cum entertainment mode so as to make the messages more appropriate, understandable and convincing (Chiovoloni, 2004). Cultural compatibility had a mean score of $(\overline{x} = 3.28)$. This could be possible because of the face to face interaction. Minimum input had a mean score of $(\overline{x} = 2.67)$. Traditional folk media according Motgnty *et. al;* (2011) operate with the motto of minimum input and maximum output. Bringing about changes in the behavior of the target audience. Attracting people had a mean score of $(\overline{x} = 3.50)$, because of the cultural affinity and belief. The songs are more acceptable to the society and their ideas are easily adopted for the behavior change because according to the performances are almost from the same community.

Conclusion

The study investigated the mean preference of songs in disseminating maternal health care messages in rural communities of Imo state. From the results, all the statement had positive and significant outcome, hence communication. Therefore, songs as a vehicle of development messages, including health and family welfare was fully preferred by the respondents because communication was practical in approach and goes to the heart and head of the people. Though advances have been made in electronic media and their reach is quite high, yet people use them for getting information but for putting the information into action, they need channels like interpersonal communication or the media which can help them remove queries where the traditional media (songs) comes into effect.

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Land Accessibility among Women Farmers and Effect on *Telferia* Production in Esit Eket Local Government Area, Akwa Ibom State, Nigeria

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Abstract
The study assessed land accessibility among women farmers and effect on Telferia production in Esit Eket Local Government Area, Akwa Ibom State, Nigeria. Specifically, the study described the socio-economic characteristics of the respondents, identified land accessibility pattern by women farmers in the study area and identified factors affecting level of access to land by women for Telferi production. A multistage sampling technique was used to select 100 respondents for the study using a well-structured questionnaire. Data obtained were analysed using descriptive statistics such as frequency, percentage, mean score and rank. The results revealed that majority of the respondents (47%) were married. Majority of the respondents had farm size ranging from 1-4ha (76%) and were engaged in Telferia production for 1-5 years (45%). On land accessibility pattern by women farmers for Telferia production, the result, revealed that land ownership by gift or freewill had the highest percentage (92%), followed by government allocation (90%) and shared cropping (86%). The study therefore recommended that arable land should be made accessible and affordable to women by government and individuals for Telferia production so as to improve their sources of livelihood diversifications and productivity in Esit Eket in particular and Nigeria in general.
Keywords: Land, accessibility, women farmers, Telferia and Esit Eket

Introduction
Agriculture provides man with food for consumption, raw materials for industries, housing and clothing among very many others. Therefore, it importance cannot be overemphasized. Land is a fixed and immobile factor of agricultural production. According to Cotula, Toulmin and Quan (2006), Aboh and Akpabio (2008), land accessibility is a situation whereby people both men and women (individually or collectively) gain rights and opportunities to occupy and utilize arable land. In otherwords, land accessibility is the opportunity to own, hold, use, manage and control land (Akpabio, 2005). *Telferia* is a leafy vegetable that are intensively grown in the southern region of Nigeria containing rich assortments of vitamins, minerals and proteins that augments the nutritive values of staple foods such as rice, maize, cassava and yam hence fighting/mitigating incidences of hidden hunger menace and malnutrition/malnourishment in Nigeria. (Akpabio, 2005; Effiong and Asikong, 2013 and Ekanem, 2018). According to Akpabio (2005) women farmers are generally less privileged and often face discriminations and limited access to rural land because of systemic gender biases in the forms of customs, tradition, cultures and norms that bars women from ownership and active participation in decision-making processes in their respective rural communities/villages hence reducing agricultural activities and productivity since women constitute approximately over 75% of the Nigerian agricultural labour force. In 2004, Asian Vegetable Research Development Centre (AVRDC) stated that vegetables are the most affordable and accessible sources of micronutrients such vitamins, minerals, proteins, sugars and essential oils that increases man's inherent resistance to debilitating diseases such as scurvy, night blindness, diabetes mellitus, diarrhea, ataxia, cardio-vascular disease (CVD), and cancer, and that, its production is recognized as a catalyst for development and as a means of foreign exchange earnings.

Methodology

The study was conducted in Esit Eket Local Government Area, Akwa Ibom State, Nigeria, Esit Eket is located at the Atlantic West-line boundaries of Ibeno, Eket and Nsit Ubium LGA's of the state. It has an estimated population of 63,701 (NPC, 2006) with 23 recognized villages with Ekid as the major dialect. The inhabitants of the area are predominantly farmers, fishermen and traders. Majority of the farmers in the area are engaged in crop and livestock production activities: *Telferia occidentalis* production in the area serves as a major source of livelihood diversification for rural households, but farmers especially women are often constrained by land acquisition patterns for *Telferia* production. Multistage sampling technique was used to select the respondents. At first stage, purposive sampling technique was used to select Esit Eket as a block from Eket Agricultural Zone. This was necessitated by the prevalent of vegetable farmers in the block. The second stage was the purposive selection of 10 cells from the block due to the intensive all year round cultivation of vegetables in the cells. In the third stage, 10 respondents were randomly selected from each of the selected cells. This produced a sample size of 100 respondents used for the study. Primary data were collected with the aid of an interview schedule and a structured questionnaire, while secondary data were obtained from relevant literatures and publications. Descriptive statistics such as frequency distribution, percentage, means scores and rank were used in analyzing the objectives and drawn conclusions.

Results and Discussion

Table 1, showed results of socio-economic characteristics of the respondents, this revealed that majority (33%) were aged 30-40 years, while (27%) were aged between 51-60 years. Also, majority of the respondent (58%) had primary education, (24%) had secondary education and a small number (12%) had no formal education implying that their level of education was relatively high. The result is in line with the findings of Effiong, Ijioma and Effiong, (2016); Effiong and Udo (2015), who asserted that a good level of formal education had direct relationship with higher economic returns, better access to agro-information, innovations, technologies, adoption/utilization and management of economic ventures. Results of household size revealed that (59%) had 1-5 persons per household, majority (76%) had 1-4 hectares of farmland, implying that the higher the number of persons per household /farm size, the higher the *Telferia* productivity (yield) and labour force for production in the rural communities. Table 2, showed land accessibility patterns by women farmers for *Telferia* production. The table revealed that (92%) of the respondents acquired land through gifts/freewill donations, (90%) through government allocations, (86%) through share-cropping and (88%) through leasing system. This result corroborates with the findings of Effiong and Efifong (2015) who reported that renting, leasing, community allocation and gifts are the land patterns predominantly adopted by most women farmers in Nigeria and are used mainly for agricultural production. Results of factors affecting womens' access to land is shown in table 3, the table revealed that high cost of land, inability to transfer land and insecured land tenure policy were ranked 1st ($\bar{X}$ = 2.67), 2nd ($\bar{X}$ = 2.38), and 3rd ($\bar{X}$ = 2.18) respectively, while inadequate land, difficulty in land transaction and limited use of land were minor factors affecting women access to land for *Telferia* production and were ranked (6th, $\bar{X}$ = 2.00), (5th, $\bar{X}$ = 2.12) and (4th, $\bar{X}$ = 2.14) respectively. This result corroborates with the findings of Adamu, (2014) and Odudu, (2015) who stated that high cost of land, inadequate land, unfertile land, land under dispute limited use of land, inability to transfer, and difficulties in land transactions among very many others were the factors affecting women access to land for crop and animal production in our rural communities. This study showed that non-availability of agricultural land negatively affected women's involvement in *Telferia* production in the study area.

Table 1: Distribution of respondents according to Socio-economic Characteristics

Variables	Frequency	Percentage
(Age)		
<30 yrs	13	13
30-40 yrs	33	33
41-50 yrs	19	19
51-60 yrs	27	27
>60	8	8
Total	100	100
(Marital status)		
Single	26	26
Married	47	47
Divorced	4	4
Widowed	23	23
Total	100	100
(Educational level)		
No formal education	12	12
Primary school	58	58
Secondary school	24	24
Tertiary	6	6
Total	100	100
(Household size)		
1-5	59	59
6-10	37	37
11 –15	4	4
Total	100	100
(Farm size)		
1-4	76	76
5-8	23	23
9-12	1	1
Total	100	100
(Farming experience)		
1-5 years	67	67
6-11 years	28	28
12-16 year	3	3
>16 years	2	2
Total	100	100
(Membership of association)		
Yes	52	52
No	48	48
Total	100	100
(Extension service)		
Yes	32	32
No	68	68
Total	100	100
(Frequency of visit)		
None	66	66
1-2	22	22
3-4	12	12
Total	100	100
(Annual income)		
<N10,000	-	-
N10000 – N50000	18	18
N51000 – N100000	36	36
N110000 _ N150000	12	12
>N150000	34	34
Total	100	100

Source: Field Survey, 2017

Table 2: Land accessibility pattern among women *Telferia* farmers in the study area

Ownership pattern	Agreed	Not agreed
Rent	76(76%)	24(24%)
Leasing	88(88%)	12(12%)
Community allocation	84(84%)	16(16%)
Share cropping	86(86%)	14(14%)
Purchase	82(82%)	18(18%)
Inheritance	73(73%)	27(27%)
Gift	92(92%)	8(8)
Government allocation	90(90%)	10(10%)

Note: Values in parenthesis represent the percentages.
Source: Field survey, 2017

Table 3: Factors affecting women's access to land in the study area

factors	VS (3)	S (2)	NS (1)	Cum	Mean	Rank
High cost of land	74(222)	19(38)	7(7)	267	2.67	1st
Inadequate land	32(96)	36(72)	32(32)	200	2.00	6th
Limited use of land	41(123)	32(64)	27(27)	214	2.14	4th
Inability to transfer land	55(165)	28(56)	17(17)	238	2.38	2nd
Insecure tenure	31(93)	56(112)	13(13)	218	2.18	3rd
Difficulty in land transaction	33(99)	46(92)	21(21)	212	2.12	5th

Source: Field survey data, 2017.VS = Very serious, S = serious, NS = not serious

Conclusion

The study concluded that majority of the respondents had a good level of formal education, farming experience and high income per annum. They accessed land for production through gifts/freewill donations, government allocations, leasing, share-cropping, community allocations and rents. Based on the findings of the study, the following policy recommendations were proferred.

- Women should be encouraged to access extension service irrespective of their tribe, race, culture, ethnicity and religious inclinations. This would improve on their innovativeness and productivity.
- Agricultural credit facilities should be accessible and affordable to women farmers at very low interest rate, to enhance farm productivity and increase income among women farmers.
- Government should encourage participation of women farmers in *Telferia* production by reducing the cost of land and regulating the process of land transactions in the rural communities.

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Rural Women Participation in Cassava Flakes (Abacha) Processing in Umunneochi LGA Abia State

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Abstract
The study was conducted among rural women in Umunneochi Local Government Area of Abia State. The people of Umunneochi are well known for cassava flakes production. One community (Isuochi), out of the 3 communities in umunneochi LGA was purposively selected and 54 women were interviewed to assess their levels of participation in the production of cassava flakes popularly known as Ighu in Isuochi or Abacha in Southeast Nigeria. Structured questionnaire and interview schedule were used to elicit the true information about cassava flakes processing among the women. Data collected were analyzed by means of descriptive statistics such as frequency distribution tables, percentages and means. A five point likert scale of strongly agree, agree, undecided strongly disagree and disagree was used to present the level of participation of the respondents. The result shows that majority of the women had the highest level of participation in cassava flakes processing in the following activities with the following mean(x) scores; storage(3.9), slicing/grating (3.8), packaging (3.8), soaking/washing of cassava flakes (3.7). The cost of processing implements used by cassava flakes processors in the study area shows that good number of the respondents (38.9%) made use of pots at the cost of N4500 – ₦9,000 per pot for the processing of cassava flakes which seems to be high. the major constraints in cassava flake production were problem of pests attack (100%), lack of water (96.2%) and climate change impact(94%). It was recommended that modern processing facilities should be made available for cassava flakes production at reduced and affordable price and water bole holes should be made available in the study area by the government.

Keywords: Participation, Rural Women, Cassava flakes (Abacha) and Processing

Introduction
Cassava is one of the major food crops grown in Nigeria as a food security crop. The significant of the crop in tropical agriculture has been recognized in the area of its growth potential human and animal food, its enrichment and fortification, industrial uses, economic of production and genetic improvement (Okereke and Ojuwale, 2005). Cassava has a great processing value it can be processed and eaten as fufu, garri, flour, flakes (abacha) and many other food products(Nwakor and Nwakor, 2012). Diversification of the uses of cassava through indigenous diets promised high capacity for fighting hunger, alleviating poverty as well as enhancing livelihood of many rural farm households. Abacha is a local and indigenous food from cassava products that is popular and highly consumed by people in southeastern Nigeria. Abacha is made from cassava tubers,. It is white and crunchy and can be eaten dry or wet as a snack with coconuts or palm kernel (Adepoju and Nwangwu(2010). Cassava flake is prepared with simple implements like Knife for peeling and cutting the cassava tubers, Bowls for washing the sliced abacha, Pot for boiling, cassava slicer/shredder for slicing the cassava tubers into abacha, big flat baskets/mat for drying them under the sun .This abacha or African salad is the major food used as a sign of acceptance to any visitor that come to the people of Umunneochi especially Isuochi. Today the food is widely eating in every part of Nigeria as a special indigenous diet people who are into abacha restaurant, hotel or even mama put business are making a good living from the business. Abacha is the major source of income among the women of Umunneochi LGA because every household in this area produces cassava flakes to prevent hunger and poverty. This work

was designed to assess the levels of participation of women in abacha processing activities in Umunneochi L.G.A Abia State.

Methodology

The study was conducted among rural women in Umunneochi L.G.A of Abia State out of the three communities in Umunnneochi LGA one community was purposively selected for this study. This is because the community is well known for cassava flakes (Abacha) production. In this community three villages were randomly selected and in each of the villages eighteen (18) women were randomly selected for this study. Well-structured and interview schedule were used to get information from the women about their level of participation in abacha processing activities the instrument and cost for processing this commodity in the study area. Data collected were analyzed by simple descriptive statistics such as frequency distribution tables percentage and mean scores involving likert scales.

Results and Discussion

The results and discussion shows the levels of participation of the women in cassava flakes (abacha) processing activities, costs and quantities of processing instruments and the constraints in abacha processing among respondents.

Table 1:Level of participation of the respondents in cassava flakes (abacha) processing

Activities	Strong participation	Fair participation	Not participation	Total	Mean
Cassava peeling	32	20	04	140	2.5
Cassava washing	28	23	03	133	2.4
Cassava boiling	46	02	06	148	2.7
Cassava slicing/grating	54	22	02	208	3.8
Cassava flake drying before washing	54	16	05	199	3.6
Cassava soaking /washing	52	23	02	204	3.7
Cassava flakes spreading in mat	45	15	01	166	3.0
Cassava flakes sun drying after washing	54	17	03	199	3.6
Routine turning of flakes under sun	51	22	00	197	3.6
Packing of the dry flakes	53	23	04	209	3.3
Storage of the flakes	49	31	05	214	3.9
Marketing of flakes	28	22	21	149	2.7

Source: Field Survey, 2018

Table 1 shows the level of participation of the women in cassava flakes processing activities which include cassava peeling, Cassava washing, Cassava slicing/grating, Cassava flake sun drying before washing Cassava flakes soaking /washing, Cassava flakes spreading on mat, Cassava flakes sun drying after washing, Routine turning of flakes under sun, Packing of the dry flakes, Storage of the flakes, Marketing of flakes. The result shows that majority of the women had the highest level of participation in cassava flakes processing in the following activities with the following mean(x) scores; storage(3.9), grating (3.8), packaging (3.8), soaking/washing of cassava flakes (3.7), drying of cassava flakes 3.6 and 3.6 respectively. There was high participation of the women in cassava flakes (Abacha) processing in the twelve activities considered.

Table 2: Quantity and cost of cassava processing implements used by respondents

Quantity	Pot	Cost	Knife	Cost	Grater	Cost	Basket	Cost	Mat	Cost	Basin	Cost
<2	24	700-3500	0	0	0	0	0	0	0	0	0	0
2-4	21	450-900	36	100-500	45	200-600	39	500-800	0	0	27	3000-3500
5-7	09	400-500	15	250500	03	2507000	15	500-800	03	800-1000	21	3000-5000
8-10	0	0	0	0	03	200-600	06	800-1000	21	1000-1300.	03	2500 -5000
11-13	0		0	0	0	0	0	0	06	1000-1200.	0	0
Above 13	0		03	200-500	03	200-500	0	0	24	700-1200	0	0

Source: Field Survey, 2018

Table 2 shows the cost and quantities of implements used by the women in cassava flakes (Abacha) processing. The result shows that the following instruments/ implements were used in the processing of cassava flakes (Abacha) among rural women in Umunneochi LGA. They were pots, knifes, slicer, baskets, spreading mat, basins. The result shows that good number of the respondents (38.9%) made use of 2-4 pots at the cost of N4500 – ₦9,000 per pot for the processing of cassava flakes. (66.6%) of respondents made use of kitchen knife at the cost of ₦100-N500 per knife, 83.3% made use of grater at the cost of ₦200 – ₦600 per grates.72.2% of the women made use of 2-4 baskets at the cost of ₦500 – ₦800 per basket for cassava flakes processing 44.4% of the respondent used above 13 cassava flakes spreading mat at the cost of N700-₦1,200 per mat. 50% of the women made use of 2-4 basins at the cost of N3000- ₦3500 per basin for cassava flakes (Abacha) processing. This analysis of cost of implements of Abacha processing show that most of the processing implements were affordable, but expensive.

Table 3: Distribution according to the Constraints in cassava flakes production

Constraints	Frequency	Percentage
Lack of land	09	16.6
Lack of fertilizer	48	88.8
Unavailability of finance	48	88.8
Lack of herbicides	27	50
Poor yield	21	38.8
No access to modern processing technologies	42	77.7
High labour cost	48	88.8
High cost of processing equip	42	77.7
Pests incidence	54	100
Climate change	51	94.4
Storage problems	18	33.3
Marketing	06	11.1
Theft	0	
Lack of storage facilities	12	22.2
Fragmentation of land	09	16.6
No access to credit	42	77.7
Lack of water	52	96.2

Source: Field Survey, 2018

The result in table 3 shows that the major constraints in cassava flake production were problem of pest attack (100%), lack of water (96.2%) and climate change (94%). Others were high cost of labour (88.8%) lack of fertilizer and lack of money (88.8%) and poor access to credit (77.7%) and no access to modern processing implements (77.7%). Many other problems constraints cassava flakes processing in Umunneochi LGA. But due to improvement in technological development some of these problems are becoming reduced.

Conclusion

The level of participation of rural women in cassava flakes production was very high. In all the activities involved in the processing of cassava root into flakes the women were highly involved. These women used this occupation to fight against food in security, hunger and poverty among the people. Both the young, middle aged to elderly women in this area were involved in the production of Abacha . These women have their challenges in the production or processing of cassava flakes (abacha) which include pest attack, climate change, lack of money, high cost of labour, lack of fertilizer for cassava production and lack of water for washing of cassava flake. Modern processing implements should be made available for cassava flakes production. Government should encourage industrial production of cassava flakes by establishing a processing plant in the area. Modern water facilities such as tap water should be provided by the government for increased production. A survey on the levels of participation of men in this activity is also recommended.

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Food Insecurity and Coping Strategies among Rural Households in Yobe State, Nigeria: A Gender Perspective

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Abstract
Food insecurity has remained a recurring decimal in the development of Nigeria despite the several efforts to tackle it. Most of the previous food insecurity studies focused on rural farming communities without regard to gender issues. Focus on gender differentials in the knowledge of technologies for coping with food security has not yet been properly addressed. The study evaluated the food security and coping strategies of farming households in Fika and Potiskum Local Government Areas of Yobe State. Data were collected with structured questionnaire and observation technique from 100 farming household and analysed using descriptive, food poverty line, and coping strategies use index it was observed that male headed household were more food secured than their female headed counterparts in the study area. The major coping strategy are planting food crops on a small scale of land, occupation diversification and harvesting food crops from the farm.
Keywords: Food security, Gender, Coping strategies, rural household and Yobe State

Introduction
During the 1996 World Food Summit of November, held in Rome, all heads of Government or their representatives at the summit pledged their support and commitments to achieving global food security and alleviation of hunger with the aim of halving the population of undernourished persons by the year 2015 (FAO, 1996). Despite this unprecedented effort by international institutions, the population of the undernourished people in the world still constitutes a major problem in most parts of the world. Food is no doubt, the most basic of all human survival needs, its availability (via production and distribution) and accessibility (i.e. affordability) remains a major challenge in developing economies. Although, so many efforts have been sunk in improving the quality as well as production of world food supplies, food insecurity remains prevalent in Nigeria. Nigeria have an energy intake of 1730Kcal and an average protein supply of 64g capita per day far below the 2500 – 3400Kcal minimum recommended daily intake per day This shows that Nigeria is facing the challenge of unbalanced diet leading to various deficiency symptoms.
Similar to other developing countries, there is a strong gender dimension to food insecurity and malnutrition in Nigeria. Women in developing countries play significant roles in maintaining the three pillars of food security- food production, economic access to available food, and nutritional security. But they play these roles in the face of enormous social, cultural and economic constraints. However, the place of gender as a fundamental issue in assuring food security both at national, household and individual levels cannot be overemphasized. Food security refers to a situation whereby individuals have access at all times to quality and sufficient food resources to maintain a healthy and active life (World Bank, 1986). On the other hand, food insecurity exists when there is constrained physical and economic access to secure sufficient quantities of nutritionally adequate food to allow individuals sustain an active and healthy living (Ifeoma and Agwu, 2014). Food insecurity comes with unpleasant conditions with consequences detrimental to human health, well-being and productivity. Consequently, when faced with food insecurity, households device strategies to minimize the impact of food insecurity and as well as to stabilize their food access. Generally, households employ different coping strategies in the early stages of

food insecurity, which however vary based on cultural and geographical differences (Maxwell, 2008) and as well as their social and economic resource endowment (Liwenga, 2003). Literature have identified that households are significantly more inclined to adopting multiple coping strategies when hit with food crisis However, the contexts that compel households to apply multiple coping strategies, are not particularly well defined. This paper is therefore an attempt to examine the coping behaviours of households and factors influencing the number of coping strategies employed. Understanding the implemented coping strategies at the household level is critical for formulating and implementing appropriate policy and design programs related to addressing the problem of food insecurity. This study was undertaken to complement the current understanding of different coping strategies pertaining to food insecurity from a gender perspective in Yobe State.

Methodology

Study area

The study area for this research is Yobe State which is located in the North – East geopolitical zone in Nigeria while the target population is all the households in the area. A multistage sampling technique was employed for this study. Two Local Government Areas (Fika and Potiskum) were purposively selected from the state. Ten communities popular for farming activities were selected across each of the two LGA's. Fifty respondents were randomly selected and interviewed across communities for each LGA making overall total respondents of one hundred. The study used primary data collected with the aid of well-structured questionnaires. Open discussions, interviews and physical observation were also employed to complement. A multistage sampling technique was employed for this study. Two Local Government Areas (Fika and Potiskum) were purposively selected from the state. Ten communities popular for farming activities were selected across each of the two LGA's. Fifty respondents were randomly selected and interviewed across communities for each LGA making overall total respondents of one hundred.

Analytical techniques

Construction of Food Poverty Line

This was done to categorise the respondents into food secure and non food secure group using the two-third mean per-capita food consumption expenditure (Oluwatayo, 2005) as the benchmark. Households whose mean consumption expenditure falls below the food poverty line are regarded as being food insecure while those with their expenditure above the benchmark are food secure. Per-capita Food Consumption Expenditure (PCFEXP) = Food Consumption Expenditure/Household Size

Total Per-capita Food Consumption Expenditure (TPCFEXP) = Summation of PCFEXP

Mean TPCEXP (MTPCEXP) = TPCEXP/ Total Number of Households

Food Poverty Line (FPL) = 2/3 * MTPCEXP

Coping strategy index (CSI)

In analysing the extent of use of the coping strategies by these households, a coping strategy index (CSI) was developed and was ranked with the weighted mean score. The CSI gives a quantitative score for each household and is an accumulative measure of the level of coping (Orewa and Iyangbe, 2010). The extent of use of the coping strategies was expressed using a four-point scale with the scoring order 3, 2, 1, 0 for frequently, occasionally, rarely and never used respectively. The formula used to obtain the CSI score was adapted from Adebo and Falowo (2015) as follows:

$CSI = N_3 X_3 + N_2 X_2 + N X_1 + N_0 X_0$-- eqn (1)

Where:

CSI = Coping strategies use index

N_3 = Number of households using a particular coping strategy frequently

N_2 = Number of households using a particular coping strategy occasionally

N_1 = Number of households using a particular coping strategy rarely

N_0 = Number of households not using any of the coping strategies.

X_4 = Scoring order for everyday

X_3 = Scoring order for frequently

X_2 = Scoring order for occasionally

X_1 = Scoring order for rarely
X_0 = Scoring order for not using any
The CSI was used in rank order to reflect the relative position of each of the coping strategy in terms of their use.

Results and Discussion

Socioeconomic Characteristics of the Respondents

The socioeconomic characteristics of the respondents are presented in Table 1. The results reveal that majority of the respondents (60%) are in the 20 – 40 years age bracket and could be classified as youth and it is expected that they are more likely to play crucial roles as care takers of household's food and nutrition security. Household heads distribution by gender reveals that there are more female-headed households (56%) than male-headed households (44%) showing that the majority of the household were headed by female. This could be as a result of the prevailing security insurgency in the study area. The educational status of the respondents shows that majority of the respondents (50%) lack formal education. This is because the state is regarded as an educationally disadvantaged state. This is similar to the findings of Shuaibu, Abdullahi, Ango, Yusuf, Sulaiman and Bello (2015). Household sizes were grouped into the range of 1-5, 6-10, 11-15, 16 -20 and more than 20.The distribution shows that 38% of the respondents fell into the range of 1-5, 34% fell into the range of 6-10, and 18% of the respondents fell into the range of 11-15, 5% fell into the range of 16 -20, while 5% of the respondents fell the range above 20. This shows that the households' size is fairly large and can contribute to the rise in household consumption especially when the household members are jobless. Farm size land holdings of the respondents reveal that majority (88%) of the respondents own between 1 -2 hectares of land. This indicates that they are small scale subsistence farmer and may not produce enough for food security. This is similar to the conclusion of Agada and Igbokwe (2014).

Table 1: Socio economic characteristics of the respondents

Variable	Frequency	Percentage
Age		
1 – 20	20	20
21 – 40	40	40
41 – 60	25	25
61 and above	15	15
Total	100	100
Gender		
Male	44	44
Female	56	56
Total	100	100
Educational background		
Non Formal Education	50	50
Primary School	20	20
Secondary School	13	13
Tertiary Institution	2	2
Arabic Education	5	5
Total	100	100
Household Size		
1 – 5	38	38
6 – 10	34	34
11 – 15	18	18
16 - 20	5	5
Above 20	5	5
Total	100	100
Farm Size (ha)		
0.1 – 1.0	47	47
1.1 – 2.0	41	41
2.1 – 3.0	8	8
Above 3	4	4
Total	100	100

Source: Field Survey, 2018

Estimates of the Food Poverty Line

The estimate of the food poverty line of the respondents is presented in Table 2. Findings in the study area shows that male households are more food secure (30%) than female households (16%) in the study areas. The findings agree with the findings of Adepoju, Ogunniyi and Agbedeyi (2015).

Table 2: Distribution of respondents by Food Poverty status and Gender.

Gender	Food Secured		Food Insecure		
	Frequency	Percentage	Frequency	Percentage	Total
Male	30	30	20	20	50
Female	16	16	34	34	50
Total	46	46	54	54	100

Source: Field Survey, 2018

Ranking of Food Insecurity Coping Strategies

The coping strategies to household food insecurity were measured on a four point scale; frequently, occasionally, rarely and never used and is shown in Table 3. The ranking was carried out with the aid of a four-point likert scale to score households' responses. These scores are 3, 2, 1 and zero for frequently used, occasionally used, rarely used and not used respectively. Generally, about 13 different coping strategies were very prominent among the available strategies employed. The study indicates that planting food crops on a small scale of land, occupation diversification and harvesting food crops from the farm were ranked first, second and third respectively. This agrees with the findings of Adebo and Falowo (2015). Other strategies adopted in descending order were reduce the number of times to eat, reduce the quantity of meals taken, cut down expenditure on food items, borrow money from friends/relatives, purchase food on credit, sale of asset such as land ,jewelries, engage children in hawking, rely on help from relatives or friends outside household, skip whole day without eating and withdraw children from school . The strategies are similar to what (Orewa and Iyangbe, 2010; Quaye, 2008) found in their studies in Nigeria and Ghana respectively. This may be because of traditional and cultural similarities between the study areas.

Table 3: Ranking of Food Insecurity Coping Strategies by coping strategy adopted

Strategy	Frequently Used(3)	Occasionally Used(2)	Rarely Used(1)	Not Used(0)	CSUI	Weighted mean	Rank
Reduce the quantity of meals taken	33	23	35	9	180	1.80	5
Reduce the number of times to eat	40	37	15	8	209	2.09	4
Sale of asset such as land ,jewelries	19	36	26	19	155	1.5.5	9
Borrow money from friends/relatives	15	45	23	14	167	1.67	7
Cut down expenditure on food items	13	54	26	7	173	1.73	6
Withdraw children from School	14	20	18	48	100	1.00	13
Engage children in hawking	20	20	38	22	138	1.38	10
Purchase food on credit	29	25	25	21	162	1.62	8
Rely on help from relatives or friends outside household	22	17	28	33	134	1.34	11
harvesting of food crops from the farm	44	36	14	6	218	2.18	3
Occupation diversification	50	30	17	13	227	2.2.7	2
Planting of food crops in a small scale of land.	52	32	11	5	231	2.31	1
Skip whole day without eating	10	40	8	42	118	1.18	12

Source: Field Survey, 2018

Conclusion

Based on the findings of the study, it could be concluded that households in the study area are food insecure and they actively adopt various strategies to improve their situation. Also, male-headed households are more food secure than female-headed households. It is therefore recommended that women should be enlightened about birth control measures to reduce household size hence, enhance food security. Also, they should be encouraged to participate in income generating activities to boost their household food security. Women literacy should be encouraged as women with formal education are more likely to adopt new technologies and increase productivity in their chosen career and invariably improve the food security of their households. Because women are the majority of the world's agricultural producers, Policies should be made to favour women and compete considerably with men in the field of Agriculture. Women should be encouraged to access productive resources like land, farm inputs and Finances.

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Access and Control of Domestic and Community Resources among Farming Households in Calabar Metropolis, Nigeria: A Gender Situation Analysis

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Abstract

A large proportion of agricultural workforce in Nigeria are women, yet they control less than 2 percent of resources and contribute more than 50 percent of agricultural produce. Women invest income in food, nutrition and education of children and sometimes pay back family debts to improve family welfare. This study examines access to and ownership of resources by gender, determine gender roles and gender relations among respondents and the constraints faced by men and women in Nigeria. A sample of 200 respondents participated in the study which was conducted in Calabar Metropolis Cross River State Nigeria. Data collection technique used three large drawings of a man, woman and a couple. A set of cards showing various resources and possessions owned by members of the communities were presented to respondents who were asked to assign ownership of each item to either man, woman or both. The result shows that 82.40% of the resources were owned and controlled by men. The findings also reveal that women played a very significant role in agricultural development by contributing 78.60% but do not have equal opportunities with men in the society. Recommendations are made for a need for gender mainstreaming in agriculture and strengthening of women-in agriculture, constitute an all–women group for group activities. The contributions of women in agricultural development should not be overlooked to enhance food security and livelihoods in Nigeria.

Keywords: Access, control, gender, and resources

Introduction

There is always a potential controversy surrounding gender analysis. Women play a significant role in agricultural development, but their contribution is often overlooked (Maunder, 1972). An extension educator must understand women's special needs and constraints. Gender unlike sex which is determine biologically is a social construct that points to relations between and among sexes, with regards to their roles and can change over time while the social expectations of tasks, responsibilities and behaviors that are considered appropriate for people of a particular sex is termed gender roles. But the manner in which people of the same or different genders interact with one another is gender relations (Manfre et al., 2012). Gender analysis is therefore "the systematic gathering and analysis of information on gender differences and social relations to identify and understand the different roles, divisions of labor, resources, constraints, needs, opportunities, and interests of various groups, including men and women, girls and boys, and transgendered persons, in a given context" (Manfre et al., 2013). In agriculture, women suffer a lot of discrimination and have an image that is very much undervalued. For example, according to Rebouché, (2006) women's farm work is often on an informal basis and it is regarded as part of their family obligations to be available to work on the farm while having no control of resources At most times, when the men have emigrated or are off working as day labourers on other farms or in other sectors, the women take care of day-to-day work on the family farm in addition to their traditional role of looking after the children and the house. The work that Women performed both on the land and in the home have been underestimated and predominantly informal and unpaid, perhaps where a wage is paid it is always lower than for men (Rebouché, 2006). Nevertheless, it is generally considered that women do 60%-80% of the farm work in developing countries (World Bank, FAO and IFAD, 2009). In other words, women are generally overworked and very little attention paid to their plights. According to ENPARD (2016), these deficiencies in the treatment of women result in limited access to social welfare benefits such as maternity leave, sick leave, pensions and social security. Forty-three percent of the agricultural workforce is women, and it can go up to 70 percent in certain regions (Doss, 2011). They control 2 percent of resources and contribute more than 50 percent of global agricultural produce. They invest income in food or nutrition, education of children and paying back debts, which together contribute to family welfare. Data from several studies point to the fact that women have very few land tenure rights as a result of the patriarchal nature of many traditional rural societies which consequently prevents women from holding or using land or makes it a herculean tasks for them to do so (FAO, 2011). Those problems are compounded by similar difficulties with access to credit and to business promotion activities. Almost in every spheres of life women are at a disadvantage in comparison with their male counterparts, suffering higher levels of un-employment, discrimination in access to land and other assets, and other socio-cultural limitations. The consequence is that in recent years we have seen a high proportion of women become internal migrants, sometimes even higher than for men due to lack of access and control over domestic and community resources (FAO, 2016). Hence, the major objective of this gender analysis in the agricultural extension context is to clarify how gender roles and relations create opportunities for and/or obstacles to achieving development objectives. Specifically,

Methodology

This study was conducted in Calabar Metropolis of Cross River State, Nigeria. Visual tools were found to be very effective in getting both men and women to focus on gender without any sense of challenge or threat and as such were used for this study (Suvedi and Kaplowitz, 2016). The tools provides insights into how access to and control of domestic and community resources vary according to gender. As the community goes through the process, it raises the awareness of community members about how assets are owned and distributed within the community. Similarly, another approach to learning about gender roles used was asking about who does some particular tasks. Who do they do it with? The technique uses three large drawings of a man, a woman and a couple (Suvedi and Kaplowitz, 2016). A set of cards show various resources and possessions owned by people in the community. Participants were shown each of the above items and asked to assign ownership of each item to either man, woman or both. The question asked is not who uses them but who owns them. The list arrived at showed the pattern of ownership and whether men or women differ in ownership. The result also shows whether women have equal power with men in the society

Results and Discussion

The result of Table 1 shows that male dominated access and ownership of resources in the study area. This was clearly shown in the predominant ownership of 14 resources out of 17 representing 82.40% of resources while the female own only 4 (17.65) out of the 18 resources listed confirming the findings of (Rebouché, 2006) women's farm work is often on an informal basis and it is regarded as part of their family obligations to be available to work on the farm while having no control of resources. For example, women had zero land title as earlier reports (FAO, 2011) suggested. On the other hand, male and female only shared 2 resources equally, that is cell phone and currency at 50% respectively.

Table 1: Access to resources

Resources	Male		Female	
	Frequency	Percentage	Frequency	Percentage
Radio	180	90%	0	0%
Vegetable plot	0	0%	200	100%
Pump set	200	100%	0	0%
Furniture	198	99%	2	1%
Fruit trees	200	100%	0	0%
Chickens	40	20%	160	80%
Jewelry	0	0%	200	100%
Bags of maize	150	75%	50	25%
Water pots	0	0%	200	100%
Harvesting machine	200	100%	0	0%
Land title	200	100%	0	0%
TV set	180	90%	20	10%
Bicycle	198	99%	2	1%
Huts	180	90%	20	10%
Trees	200	100%	0	0%
Cell phone	100	50%	100	50%
Currency	100	50%	100	50%
Total	200	100%	200	100%

Source: Field survey, 2017

Table 2: Task and Role performance by gender

Task/Role	Male		Female	
	Frequency	Percentage	Frequency	Percentage
They prepare the fields	100	50%	100	50%
They plant crops	0	0%	200	100%
They transplant seedlings	20	10%	180	90%
They weed fields	20	10%	180	90%
They harvest and irrigate	50	25%	150	75%
They clean the houses	5	2.50%	195	97.5
They wash dishes and clothes	20	10%	180	90%
They prepare food	0	0%	200	100%
They process grains	100	50%	100	50%
They collect and carry water	0	0%	200	100%
They select seeds	0	0%	200	100%
They gather firewood	0	0%	200	100%
They care for the animals	100	50%	100	50%
They care for the elderly and the very young	20	10%	180	90%

Source: Field survey, 2017

Table 2 result indicate that out of a total of fourteen (14) tasks, female predominantly performed eleven (11) of such tasks representing 78.60% while the male performed the remaining 21.4%. More so, both male and female performed three (3) tasks equally which are field preparation, grains processing and care for animals thereby corroborating the findings of (World Bank, FAO, IFAD, 2009 and Doss, 2011) that women contribute 60%-80% of the farm work in developing countries. Hence, women lack access and control over domestic and community resources (FAO, 2016).Gender mainstreaming is the way forward for gender equity and development in agriculture to enhance food security and livelihoods in Nigeria.

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ADDENDUM


agribusiness
Agribusiness
Agric. Extension
Agric. Mechanization
Animal Production
Climate Change
Crop Production
Fisheries
Food Science
Forest Resources
Gender Mainstreaming
Soil Conservation
ADDENDUM

ASN 52nd Annual Conference Proceedings

Assessment of Constraints Militating Against Agribusiness Enterprises in Ikwuano Local Government Area of Abia State

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Abstract
The study assessed the constraints and socioeconomic attributes of agribusiness entrepreneurs in Ikwuano LGA in Abia State. A well-structured questionnaire was used to collect data from the respondents. Data analyses were carried out using descriptive analytical tools such as means, frequencies, percentages and likert scale. Results showed that the mean age of the respondents was 42.5 years. Majority (71.7%) of the farmers in the study area were married while 23.3 % of them were single. majority (90%) had formal education while 10.0% of them had no formal education. On average, the farming household has spent about 12 years in farming. Inadequate capital (4.40), was the most important constraint militating against agribusiness enterprises in the study area. This was followed by lack of appropriate technology (4.33), and high transportation cost, poor policy articulation, inadequate infrastructure, inadequate market information and no incentives with means of 3.63, 3.50, 3.83 and 3.25 respectively. The results therefore call for policies aimed at addressing these constraints for enhanced participation in agribusiness enterprises in the study area.
Keywords: Assessment, Socioeconomic, Attributes, Constraints, and Entrepreneurs

Introduction
Agribusiness is considered essential in achieving sustainable economic growth and significant level of food security in an under developed country like Nigeria. Its importance in accelerating the pace of economic growth cannot be over emphasized given its usefulness in determining the efficiency and effective capacity of the nation's production system (Oyeranti, 2008; Nto and Mbanasor, 2008). NIPC (2008) observed that productivity in agribusiness sector is critically important if output is to increase at a sufficient level to meet escalating demand for food. This is true following empirical data which revealed that while food output increased at 2.5%, food demand increased at a rate more than 3.5% due to high rate of population growth of 3.18% (FOS, 1996; ABSEEDS, 2005; FRN 2009). Efforts by government to ensure that the deficit is augmented will turn to naught if a critical and fundamental review of the determinants of productivity in the subsector is not examined (Ojo, 2003; Prasada-Rao et al., 2004; NIPC, 2008). Improving the production system and capacity of agribusiness firm in emerging economy like Nigeria through increase productivity is an important policy goal especially now that agribusiness represents an important sector in agricultural commercialization of the economy. Block (1995) asserted that within the context of growth in food and poverty alleviation, emphasis should be placed on productivity increase arising from output maximization at constant or decreasing input. By extension, indices on productivity increase should be predicated upon maximization of output at minimum input (Nto and Mbanasor, 2008). This becomes necessary following the 29% productivity decline in individual agribusiness firms and 2.5% average annual decrease contrary to the targeted average annual productivity increase of 6% (Vallano et al. 2005; FARA, 2006 and Prasada-Rao et al. 2004)

Methodology
The study was carried out in Ikwuano Local Government Area of Abia State, Nigeria. Ikwuano is approximately 14km away from the state capital, Umuahia town. Ikwuano lies between latitude 5.5 N and longitude 7.5 E. Ikwuano is made up of four major historic clans: Ibere, Oloko, Ariam and Oboro, from which the existing autonomous communities and villages come from. In the first stage,

two of the historic clans namely Ariam and Oboro were randomly selected from the Local Government Area. In the second stage, three autonomous communities from each clan's communities were randomly selected. In the third stage, 2 villages were selected from the selected autonomous communities respectively. Finally, from the selected autonomous communities, five agribusiness entrepreneurs were randomly selected from each village, given a total of 60 respondents for the study. Primary data was obtained using a well-structured questionnaire. Descriptive statistics like frequency, percentages and means were used for data analysis

Results and Discussion

The age distribution of the farmers in Ikwuano Local Government Area is shown in Table 1. The results show that 6.67% of the respondents were below 21yrs old and between 41-50 and 51-60yrs each. About 38.3% and 31.7% were within the age ranges of 21-30 and 31-40yrs respectively. The mean age of the respondents was 42.5 years. This is an indication that the farmers in the study area were mostly middle aged within the active productive work force. This has implication on agricultural production because of the ability of this segment of the population to effectively withstand the rigors, strain and stress involved in agricultural production. This is in line with the findings of Onyenucheya (2007). The table shows that majority (71.7%) of the farmers in the study area were married while 23.3 % of them were single. Also, 3.3% and 5.0% of them were widowed and divorced respectively. This therefore implies that the married were more involved in farming because of the need to supplement the family's means of livelihood (Adegboye *et al*, 2008). A mean was 4 persons was obtained for household. The economic implication is that it will provide the agribusiness enterprises with family labour and reduce cost of production, marketing and increase their revenue. This corroborates Adegbite and Oluwalana (2004), that a relatively large household size may likely enhance family labour supply. The Table revealed that majority (90%) of the farmers had formal school education while 10.0% of them had no formal education. Possession of literacy (ability to read and write) would enable the farmers to better utilize effectively and efficiently whatever available resources in the area and curtail frivolous spending. As expected, higher education would enhance improved technology adoption hence increased farm income (Njoku and Odii 1991; Ezeh, 2007). On average the farming household spent about 12years in farming. The result has some positive implications on increased output of the farmers because according to Nwaru (2004), as the number of years a farmer has spent in farming business may give an indication of the practical knowledge he has acquired on how he can overcome certain inherent farm production problems. Also it has been noted that farmers would count more on their farming experience for increased productivity rather than educational attainment. (Olomola 1988; Obasi, 1991 and Nwaru 1993).

Table 1: Distribution of the Respondents according to Socio-economics characteristics

Age (years)	Frequency	Percentage
Less than 21	4	6.7
21-30	23	38.3
31-40	19	31.7
41-50	4	6.7
51-60	4	6.7
Total	60	100.0
Mean	42.5	
Marital Status		
Single	14	23.3
Married	43	71.7
Widowed	2	3.3
Divorced	1	1.7
Household Number		
1-3	27	45.0
4-6	23	38.33
7-9	9	15.00
10-12	1	1.67
Educational Level		
No formal Education	6	10.0
Primary Education	36	60.0
Secondary Education	14	23.3
Tertiary Education	4	6.67
Farming experience (years)		
1-5	4	6.67
6-10	16	26.67
11-15	28	46.67
16-20	11	18.33
21-25	1	1.67

Source: Field survey data 2018

Analyses of constraints faced by the respondents are shown in Table 2. A 5 point likert scale was used to analyze the respondents' opinions on the selected constraints of agribusiness enterprises. An average rate of 3.00 was used to indicate that the constraints are important. Results show that inadequate capital (4.40) on the average was the most important constraint militating against agribusinesses in the study area. Inadequate capital has been a hindrance for participation in agribusinesses among the entrepreneurs in the study area. As a result of the problems bedeviling credit assessment, entrepreneurs found it difficult to obtain credit from commercial banks for investment. This was followed by lack of appropriate technology (4.33), high transportation cost, poor policy articulation, inadequate infrastructure, inadequate market information and no incentives with rating means of 3.63, 3.50, 3.83 and 3.25 respectively. These indicates that they were all important factors militating against agribusinesses in the study area

Table 3: Constraints Militating against Agribusiness Enterprises in the Study Area

CONSTRAINTS	SA	A	D	SD	UD	N	MEAN	REMARK
Poor Policy Articulation:	20	16	11	8	5	60	3.63	Accepted
Inadequate Working Capital:	32	22	4	2	0	60	4.40	Accepted
Lack of Appropriate Technology:	31	22	3	4	0	60	4.33	Accepted
Inadequate Infrastructure:	15	14	20	8	3	60	3.50	Accepted
High transportation cost	32	14	4	6	4	60	4.07	Accepted
Inadequate market information	22	22	3	10	3	60	3.83	Accepted
No incentives	10	15	21	10	4	60	3.25	Accepted

Source: Survey Data, 2018

Conclusion

The study investigated the constraints and socioeconomic attributes of agribusiness entrepreneurs in Ikwuano LGA, Abia state. The result shows majority of the entrepreneurs were still young and active, married, educated with large household sizes and long years of agribusiness experience. The most important constraint militating against agribusinesses in the study area was inadequate capital, followed by lack of appropriate technology, high transportation cost, poor policy articulation, inadequate infrastructure, inadequate market information and no incentives. The results therefore call for policies aimed access to credit at little or no interest rates, provision of infrastructure especially good road networks to reduce transactions cost and access to market information especially prices. These will enhance participation and investment in agribusinesses in the study area.

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Comparative Analysis of the Economics of Dry and Rainy Season Fluted Pumpkin Production in Bende Local Government Area, Abia State, Nigeria

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Abstract
The study analysed the comparative analysis of the economics of Rainy and Dry Seasons' fluted pumpkin production in Bende local government of Abia State, Nigeria. A two-stage sampling technique was employed to select 60 farmers who produce fluted pumpkin during rainy and dry seasons in the study area. Data were analyzed using frequency counts, percentages, means and budgetary technique. The result of the socioeconomic characteristics showed that majority of the farmers were females, whom were married and educated with a mean age of 39.8 years, household size of about 6 persons and farm size of 1.01 hectares. Also, majority (75%) of the fluted pumpkin farmers had no access to credit, while 58.3% were members of different cooperative societies with mean farming experience of 13.8 years. The results of the costs and returns of the fluted pumpkin farmers gave net profit of ₦24894.2 and ₦38010.84 for rainy and dry season fluted pumpkin respectively. The benefit cost ratio per 0.5 hectare of fluted pumpkin production were ₦1.69 and ₦1.95 for rainy and dry season respectively which indicates that for every ₦1 invested in fluted pumpkin production, the farmer realizes ₦1.69 and ₦1.95for rainy and dry season respectively. The major constraints to fluted pumpkin production during the rainy season were lack of storage facilities, poor price, insufficient land and post-harvest losses due to perishable nature of the produce while lack of irrigation facilities, poor weather, high cost of labour, pest infestation and poor access to credit were the major constraints militating against dry season fluted pumpkin production in the study area. The study recommends that massive dry season fluted pumpkin production should be intensified through provision of low-cost irrigation facilities to women farmers in order to increase production and income.
Keywords: Dry and Rainy Season, Fluted Pumpkin, Cost and Returns

Introduction
Telfairia occidentalis commonly called fluted pumpkin is a tropical vine grown in the rain forest zone of West Africa. It is mainly cultivated as a leafy fluted pumpkin and it is used primarily in soups and herbal medicines or pot herbs. The consumption of fresh, green and yellow fluted pumpkins is generally inadequate. FAO (2009) reported that some 60% of the households in less developed countries derive more than 80% of the calories from cereals, starchy, root and sugar, implying that some 60% of households in these part of the World live on diets which are inadequate in nutritional quality, but fluted pumpkins are rich in vitamins and minerals, they also add to the bulk of the diet and help the body to achieve smooth digestion of food. Its production is increasingly recognized as a means of increasing foreign earning, (AVRDC, 2004). Apart from the income generating potential of fluted pumpkin production, it equally plays crucial role in off-setting the food budget of households involved. It provides an effective use of marginal lands and is crucial towards hunger reduction, poverty alleviation and promotion of growth and development. In spite of the lofty potential of the fluted pumpkin, its supply can barely match the growing consumption of the Nigeria populace. Per capita fluted pumpkins and fruits intake in Nigeria is still less than the 400g per day recommended by the World Health Organization as the minimum requirement for the growth and development of the body (Mirmiran, 2009). Moreover, farmers who depend on fluted pumpkin as a source of livelihood still live on low and unstable incomes. In Nigeria, there are two distinct seasons for fluted pumpkin production, the peak and the lean seasons. During the lean (dry) season, fluted pumpkins are produced in low quantities, scarce and expensive to get. In the peak (peak) season, it is produced in large quantities much more

than what the local populace can consume (Farinde, *et al.,* 2009). However, despite the favorable features of rainy season fluted pumpkin production there have not been established clear cut evidence as to whether the highest income is being made in this season or during the dry season. The knowledge of when the highest production is made in this area is important to take care of the patterning of fluted pumpkin production, bearing in mind the lean and peak period that will serve as a base for policy making. From the above deduction this study estimated the costs and returns associated with dry and rainy season fluted pumpkins production in the study area and identified factors militating against dry and rainy season fluted pumpkin production in the study area

Methodology

The study was conducted in Bende Local Government Area (L.G.A) of Abia state. Bende Local Government is composed of thirteen (13) communities, namely: Alayi, Bende, Ezukwu, Igbere, Item, Itumbuzo, Nkpa, Ntalakwu, Ozuitem, Ugwueke, Umu-imenyi, Umuhu-Ezechi, and Uzuakoli. The population of Bende LGA according to the 2006 population census was 192,621 persons (NPC, 2006). Bende L.G.A has agric-climatic conditions typically of the tropics. Bende is bounded in the north by Cross River State, Afikpo and Ohaozara, and in the South by Arochukwu and Ohafia, while in the East and West by Ikwuano L.G.A. and Umuahia L.G.A respectively. Agriculture is widely the occupation of the people and it a major fluted pumpkin producing area in Abia state.

Two-stage sampling techniques were used in selecting the respondents used for the study. In the first stage, 3 communities namely; Bende, Umu-imenyi, and Umuhu-Ezechi were randomly selected. The second stage involved listing of all the fluted pumpkin farmers from the 3 communities which formed the sampling frame from which 20 fluted pumpkin farmers were randomly selected in each chosen community to give a sample size of 60 respondents.

Data were collected by the use of structured questionnaire administered to the respondents and interview schedules and relates to the 2017 cropping season. Data were analyzed using frequency counts, percentages, means and budgetary technique. The models are specified as follows:

$$\text{Net Profit} = \pi = TR - (TFC + TVC) \quad (1)$$

Where π	=	profit
TR	=	Total revenue
TFC	=	Total fixed cost
TVC	=	Total variable cost

$$\text{Return on Investment} = \frac{Revenue}{Total\ Cost} \quad (2)$$

Results and Discussion

Socio-economic Characteristics of Respondents in the Study Area

The socio-economic profile of dry and rainy season fluted pumpkin farmers is shown in Table 1. The analysis of the socio-economic characteristics of fluted pumpkin farmers in the study area show that majority (76.7%) of the farmers were females, while 23.3% where males. These indicate that female seem to dominate fluted pumpkin farming in the study area. The distribution of the respondents based on age showed that 50% of the farmers were between the age ranges of 36-45 years, 33.3% were between the age range of 26-35 years while 10% and 6.7% were between the age range of 46-55 and 56-65 respectively. The mean age of the farmers was 39.8 years indicating that fluted pumpkin farmers in the study area were young and still in their productive age. The distribution of the respondents based on their marital status showed that majority (70%) of the fluted pumpkin farmers were married while 18.3% and 11.7% were single and widowed respectively. The distribution of the respondents based on their level of education showed that 46.7% of the farmers had secondary education, 26.7% had primary education while 21.7% had tertiary education. Five percent of the farmers had no formal education in the study area. The mean years spent in school of the farmers was 12.8 years indicating that majority of the farmers were literate and that level of education may have helped them the choice of cultivating fluted pumpkin both in dry and rainy season.

Table: 1: Socio-economic Characteristics of respondents in the study Area

Variable	Dry and Rainy Season Fluted pumpkin Production		
	Frequency	Percentage	Mean
Sex (HH Head)			
Male	14	23.33	
Female	46	76.67	
Age (HH Head)			41.1
26 – 35	20	33.33	
36 – 45	30	50.00	
46 – 55	06	10.00	
56 – 65	04	6.67	
Marital Status			
Single	11	18.33	
Married	42	70.00	
Widowed	7	11.67	
Level of Education (HH Head)			12.80
No formal Education	3	5.00	
Primary	16	26.67	
Secondary	28	46.67	
Tertiary	13	21.67	
Household size			5.6
1 – 3	16	26.67	
4 – 6	24	40.00	
7-9	20	33.33	
Farm Size			1.01
0.1 – 0.5	30	50	
0.6 – 1.0	20	33.33	
1.1 – 1.5	10	16.67	
Access to Credit			
Access	15	25.00	
No Access	45	75.00	
Cooperative Membership			
Member	35	58.33	
Non Member	25	41.67	
Farming Experience			13.83
4-9	21	35.00	
10-16	25	41.67	
17-22	14	23.33	

Source: Field Survey, 2017

This result is in line with (Ironkwe *et al.,* 2007 and Adekunmi *et al.,* 2017) who separately asserted that education increases the ability of the farmers to understand and evaluate new production techniques. The distribution of the respondents based on their household size showed that 40% of the fluted pumpkin farmers had a household size of between 4-6 persons, 33.3% had between 7-9 persons while 26.7% had between 1-3 persons. The mean household size was about 6 persons indicating that the farmers in the study area had a moderate household size that could help in supplying the needed labour for both dry and rainy fluted pumpkin farming. This might have implication for available family labor force. The distribution of the respondents based on their farm size showed that 50% of the farmers farmed between 0.1-0.5 hectare of land for both dry and rainy season fluted pumpkins, 33.3% farmed between 0.6-1.0 hectare of land, while 16.7% farmed between 1.1-1.5 hectares of land for both dry and rainy season fluted pumpkins in the study area. The mean farm size was 1.01 hectares. The distribution of the respondents based on their access to credit showed that majority (75%) of the fluted pumpkin farmers had no access to credit while 25% had access to credit. The distribution of the respondents based on their membership of cooperative society showed that majority (58.3%) of the fluted pumpkin farmers were members of cooperative society why 41.7% were non- members of cooperative societies in the study area. The distribution of the respondents based on their farming experience showed that 41.7% had between 10-16 years' experience in fluted pumpkin farming, 35% had between 4-9 years' experience in fluted pumpkin farming while 23.3% had between 17-22 years' experience in fluted pumpkin farming in the study area. The mean farming experience was 13.8 years, which implies that the farmers had gotten considerable farming experience. Farmers experience is expected to have a considerable effect on farmer's productive efficiency

Cost and returns Analyses of 0.5 hectare dry and rainy season fluted pumpkin (Telferia) production

The cost and returns analyses of dry and rainy season fluted pumpkin production in the study area is presented in Table 2

Table 2 Costs and Return Analysis of Dry and Rainy Season Fluted pumpkin Production in Ikwuano LGA

Item/Operation	Rainy Season Fluted pumpkin			Dry Season Fluted pumpkin		
	Quantity	Price	Value	Quantity	Price	Value
Revenue	94 bundles	650	61100	71 bundles	1100	78100
Variable Cost						
Cost of Clearing	2.33 Mandays	1200	2800	1.6 Mandays	1200	1910
Cost of Cultivation	3.29 Mandays	1200	3950	1.56 Mandays	1500	2350
Cost of Planting	1.65 Mandays	1200	1980	1.56 Mandays	800	1250
Cost of Planting Material	20 Heads	180	3600	23.2 Heads	200	4640
Cost of Organic Manure	9.1 Bags	500	4550	7.84 Bags	500	3920
Cost of Inorganic Manure	7.85 Kg	260	2040.45	7.73 Kg	260	2010.50
Cost of Chemical	2.0 Litres	500	1002.2	1.74 Litres	500	870.86
Cost of Weeding	2.2 Mandays	1200	2640	1.81 Mandays	800	1450
Cost of Irrigation				17.1 Mandays	500	8550
Cost of Harvesting	3.8 Mandays	1200	4552	4.75 Mandays	800	3800
Total Variable Cost			27114.65			30751.36
Fixed Cost						
Rent	Season		6500	Season		6370
Depreciation			2591.15			2967.8
Total Fixed Cost			9091.15			9337.8
Total Cost			36205.8			40089.16
Net Profit			24894.2			38010.84
Return on Investment			1.69			1.95

Source: Field Survey, 2018.

To realize profitability of fluted pumpkin production, a specific unit of land (0.5 hectare) was used to compute cost and returns of fluted pumpkin production among the farmers in both rainy and dry seasons for 2017 cropping season. The variables considered and used for comparison in both rainy and dry season fluted pumpkin production were yield, revenue, variable cost, net profit and benefit-cost ratio (BCR). Table 2 showed that the total revenue per 0.5 hectare of land for dry and rainy season fluted pumpkin production were ₦78100 and ₦61100 respectively. The revenue was gotten from the sale of an average of 71 bundles of fluted pumpkin at the rate of ₦1100 per bundle during the dry season while the sale of average of 94 bundles at the cost of ₦650 per bundle during the rainy season. The figures indicate that the revenue generated from fluted pumpkin production during the dry season is higher than that obtained during rainy season, although higher yield is obtained during rainy season. This implies that fluted pumpkin production attracts high income in both season but higher price in dry season. The findings are consistent with Bamire and Oke (2003) and Nwalieji *et al.,* (2015) who observed that okra yield was higher during the rainy season, while higher total revenue was obtained under dry season conditions. The total mean variable cost for fluted pumpkin production during rainy season cropping was ₦27114.65 while that of dry season was ₦30751.36. This implies that the cost incurred by farmers in fluted pumpkin production in 0.5 hectare during dry season cropping is higher than that of rainy season; the high variable cost during the dry season is attributed to the cost of irrigation that is not applied during the rainy season. The mean total fixed cost for fluted pumpkin production per 0.5 hectare of the farmers during the rainy and dry seasons were ₦9091.15 and ₦9337.8 respectively while the total cost were ₦36205.8 and ₦40089.16 for rainy and dry season fluted pumpkins respectively. The result of the net profit for fluted pumpkin production per 0.5 hectare showed a net profit of ₦24894.2and ₦38010.84 for rainy and dry season fluted pumpkin respectively. The benefit cost ratio of fluted pumpkin production were ₦1.69 and ₦1.95 for rainy and dry season respectively which indicates that for every ₦1 invested in fluted pumpkin production, the farmer realizes ₦1.69 and ₦1.95for rainy and dry season respectively. This implies that fluted pumpkin production during the dry season is though cost ineffective but attract high market price than the rainy season fluted pumpkin production, hence the reasons for engaging in the production as it can serve to supplement farm income during the off-season. This is in agreement with Alimi (2005) and Nwalieji *et al.,* (2015) which observed that mono-cropped okra production was profitable in both seasons, but profits were higher in the dry season. Also, in line with this, Edet and Etim (2010) indicated from profit analysis carried out that okra production is profitable with an average profit of N35, 781.7 per hectare; and commends a high market price in Nigeria markets because it features daily in the diets of most Nigerians.

Constraints Militating Against Dry and Rainy Season Fluted Pumpkin Production in Bende LGA

The constraints militating against dry and rainy season fluted pumpkin production is presented in Table 3.

Table 3: Distribution of respondents on the basis of constraint encountered in different season

Constraints	*Rainy Season	*Dry Season
Lack of Storage Facilities	45 (75)	3 (5)
Disease infestation	18 (30)	3 (5)
Pest infestation	6 (10)	21 (35)
High cost of labour	10 (16.7)	24 (40)
Poor price	30 (50)	0 (00)
Poor Weather	6 (10)	25 (41.7)
Insufficient land	26 (43.3)	8 (13.3)
Post-harvest losses due to perishable nature of produce	22 (36.7)	2 (3.3)
Poor access to credit	21 (35)	21 (35)
Poor extension contact	15 (25)	15 (25)
Lack of Irrigation Facilities	0 (00)	48 (80)

Source: Field Survey, 2018, *Multiple response Note, figures in parenthesis are percentages

Table 3 shows the percentage distribution of the identified constraints militating against dry and rainy season fluted pumpkin production in the study area. The result showed that lack of storage facilities, poor price, insufficient land; post-harvest losses due to perishable nature of the produce and poor access to credit were the major constraints militating against rainy season fluted pumpkin production in the study area, while lack of irrigation facilities, poor weather, high cost of labour, pest infestation and poor access to credit were the major constraints militating against dry season fluted pumpkin production in the study area The findings on constraints facing fluted pumpkin farmers are in line with Onuk *et al.,* (2010) who stated that farmers are generally faced with constraints that can limit production. Also, Edet and Etim (2010) identified insect and disease attack, lack of storage facilities, lack of improved varieties of seeds, insufficient capital, lack of extension agents' visit and lack of government assistant as major constraints that affect okra production. The implication of this according to Farinde, Owolarafe and Ogungbemi (2009) is that production of fluted pumpkin will remain stagnant due to the many identified constraints.

Conclusion

Women highly engaged in both rainy and dry season fluted pumpkin production enterprises as major source of income. Also, the results of the profitability analysis for fluted pumpkin production per 0.5 hectare of the farmers during 2017 rainy and dry season cropping showed that fluted pumpkin production in both seasons is profitable and lucrative, but more in dry season. Lack of irrigation facilities, poor weather, high cost of labour, pest infestation and poor access to credit were the major constraints militating against dry season fluted pumpkin production in the study area while lack of storage facilities, poor price, insufficient land, post-harvest losses due to perishable nature of the produce and poor access to credit were the major constraints militating against rainy season fluted pumpkin production in the study area. It is recommended that efforts be geared toward making fluted pumpkin production more viable and lucrative in the study area.

This could be done by educating women farmers on how to increase their productivity, income and sales through extension services. Also massive dry season fluted pumpkin production should be intensified through provision of low-cost irrigation facilities to women fluted pumpkin farmers in order to increase production and income. There is also the need for women to have good access to loan facilities with low interest rate in order to motivate them into practicing commercialized fluted pumpkin farming. This should be made available to them by stakeholders such as governments, CBN, donor agencies, etc. through formation of viable co-operatives.

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Effect of Different Mulch Materials (*Azardirachta indica*, *Gmelina arborea* and *Chromolaena odorata*) on the Yield of Sweet Potato (*Ipomoea batatas*)

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Abstract
A field study was conducted at the research site of Federal College of Agriculture, Ishiagu in 2017 with the objective of comparing the effect of three different source of mulch materials (Azardirachta indica, Gmelina arborea Chromlaena odorata) on the yield of sweet potato (Ipomoea batatas). The mulch materials were T_1 - Azardirachta indica, T_2 - Gmelina arborea, T_3 - Chromolaena odorata and T_4 - control. The treatments were replicated four times each using Randomized Complete Block Design (RCBD). The research work lasted for a period of four months. The analysis of variance indicated that there were significant difference ($P<0.05$) among the treatments and between the parameters measured. Treatment 1 and 3 indicated an improved yield than control and treatment 2. It was recommended that mulching materials should be used in crop production since it significantly improve yield.
Keywords: mulching, yield, and sweet potato

Introduction
Sweet Potato is among the world most cultivated food crop, it is socially accepted across the globe without any cultural or religious inhibition, easy to cultivate and mature within a space of time unlike other staple crops (FAOSTAT, 2010). The sweet potato's biggest draw is its impressive concentration of caroteniods, which are colourful pigments that our bodies can convert into the important antioxidant vitamin A. It is a source of manganese which plays a major role in metabolism of carbohydrate that supports healthy blood sugar level. It also contains much fibre which helps to prevent constipation. It is also rich in vitamin C and E which potent antioxidant vitamins that play an important role in disease prevention and longevity (Collins, 1993, Cabanilla, 1996; Jasson, and Kanan, 1991). Most often poor soil nutrient hamper good yield and effort to intensify the use of synthetic fertilizers and agrochemical is being discourage because of their toxicity to the ecosystem and the consuming public. Production effort globally is tending toward sustainable agriculture which emphasizes among others the use of organic sources of soil amendment and as pesticides. Towards this end, this study would be focusing on the effect of different source of mulch materials on the yield of sweet potato so as to determine the best mulch materials that can be recommended to farmers who engage in sweet potato production.

Materials and Method
Study Area
The research farm of Federal College of Agriculture, Ishiagu lies within latitude $05^{o}56^{1}$N and longitude $07^{o}41^{1}$E in the derived savanna zone of Southeastern Nigeria. The area has a tropical wet and dry climate with a mean temperature and rainfall of 30^{o}C and 1539mm.
Experimental Materials
The experimental material includes the test crop: Sweet potato (*Ipomoea batatas*) vines from National Root Crops Research Institute (NRCRI), Umudike.
T_1-Neem leaves (*Azardirachta indica*), T_2 - Gmelina leaves (*Gmelina arborea*)
T_3 - Siam weed (*Chromolaena odorata*), T_4 - Control
Experimental design used was Randomized Complete Block Design (RCBD) with the treatment replicated four times.

Agronomic Practices
The project site was cleared with cutlass, the debris removed with rake and the land was tiled with West African hoe to the required measurements. The manure was incorporated on the beds and allowed to cure for one week as a basal application on the 16 beds. The mulch materials were also incorporated on the beds at the rate of 12kg per bed in a Randomized Complete Block Design (RCBD). The potato vines were planted one week after the incorporation of the treatments (mulch materials); *Azardirachta indica*, *Gmelina arborea* and *chromolaena odorata*. The potato vines were planted at a planting distance of 50cm by 50cm. Weed control was done with the aid of weeding hoe with frequent inspection of the project site. Pest and disease was controlled biologically. Harvest was done manually with hand.

Parameters to be measured
Data were collected on the following:

- Vine length at 2, 3, 4, 5, 6, 7 and 8 Weeks after Planting (WAP).
- Number of leaves at 2, 3, 4, 5, 6, 7 and 8 Weeks after Planting (WAP).
- Weight of tubers at harvest (kg).

Data Analysis
Data collected were subjected to statistical analysis using analysis of variance ANOVA, according to the procedure for the RCBD as described by GENSTAT 37.2 edition. The significant means were separated using LSD at 5% level of significance or 0.05 probability level or 0.05%.

Results and Discussion

Mean Number of Leaves of Sweet Potato
Table 1 shows the effect of the treatments on the mean number of leaves of sweet potato at 2, 3, 4, 5, 6, 7 and 8 weeks after planting. The analysis of variance also indicated that there were significant difference ($P<0.05$) among the treatments.

Table 1: The Effect of the Treatments on the Mean Number of Leaves of Sweet Potato

	Treatment				
Weeks	T1	T2	T3	T4	LSD
2 WAP	23.63	8.81	7.88	7.13	5.16
3 WAP	28.06	16.75	14.88	13.00	2.63**
4 WAP	36.38	25.50	23.44	13.00	2.34***
5 WAP	49.50	34.69	32.69	31.13	2.62**
6 WAP	61.19	44.00	42.00	40.44	2.60**
7 WAP	72.69	52.88	51.44	49.50	2.32**
8 WAP	87.59	57.75	61.19	62.38	2.43**

*** & ** Significant at 5% and 10% alpha level, NS not significant.

Mean Vine Length (cm) of Sweet Potato
Table 2 shows the effect of the treatments on the mean vine length of sweet potato at 2, 3, 4, 5, 6, 7 and 8 weeks after planting. The analysis of variance also indicated that there were significant difference ($P<0.05$) among the treatments.

Table 2: The Effect of the Treatments on the Mean Vine Length of Sweet Potato

	Treatment				
Weeks	T1	T2	T3	T4	LSD
2 WAP	13.66	8.13	17.88	5.22	2.69***
3 WAP	54.81	74.81	42.19	26.00	6.18***
4 WAP	123.06	84.06	102.58	94.13	27.93
5 WAP	215.41	236.38	188.16	170.07	5.65***
6 WAP	317.97	284.82	297.82	272.07	6.23***
7 WAP	399.56	376.07	384.66	367.69	9.49*
8 WAP	498.00	471.97	485.97	440.00	20.66*

*** & ** Significant at 5% and 10% alpha level, NS not significant.

Mean Weight of Tubers at Harvest (kg)
Table 3 shows the effect of the treatments on the mean weight of tubers of sweet potato. The analysis of variance also indicated that there were significant difference ($P<0.05$) among the

treatments. This result is in line with similar study from Nunez, (2013), Maduakor *et al*., (1984) and Collins, (1994).

Table 3: The Effect of the Treatments on the Mean Weight of Tubers (kg)

Treatment	Mean
T1	8.68
T2	4.60
T3	6.55
T4	2.98
LSD	1.57***

Conclusion

Azardirachta indica mulch (T_1) gave the highest mean weight of 8.68kg, followed by *Chromolaena odorata* mulch (T_3) with 6.55kg followed by *Gmelina arborea* mulch (T_2) with 4.60kg. The control (T_4) gave the least mean weight of 2.98kg. The results of this study indicated that mulching materials are useful in improving the soil fertility and subsequently crop yield. Based on the finding of this study, it is recommended that mulching materials should be used in crop production since it significantly improve crop yield.

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Effects of Potassium Application on the Growth, Yield and Nutritional qualities of Soybean (*Glycine Max*) in a derived Guinea savanna of Nigeria

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Abstract
A field experiment was carried out to evaluate the effect of five levels of potassium (0, 15, 30, 45, and 60 kg K/ha) on the vegetative, yield parameters and protein contents of soybean. The experiment was a 3 x 5 factorial experiment arranged in a randomized completed block design and replicated three times; the factors are five levels of potassium using muriate of potash and the three cultivars of soybean (TGX1987-62F, TGX1835-10E and TGX1910-14F). The results showed that the highest plant height (37.1 cm) and highest number of leaves (29.2) obtained at 8 weeks after planting (WAP) when 30 kg K/ha was applied were not significantly different from other means. The highest mean pod weight (1827 kg/ha) was obtained when 30 kg K/ha was applied. The highest nitrogen content (6.6%) and potassium content (2.1%) was obtained when 15 kg K/ha was applied while the highest calcium content was obtained when 0 and 60 kg K/ha was applied. Potassium application at 15 kg K/ha gave the highest percentage of protein content of 41.4%. In conclusion, TGX1910-14F treated with 15 kg K/ha in the trial location maximized the productivity and nutritional quality of soybean.

Introduction
Constraint analyses have indicated that unbalanced soil nutrition is one of the most important reasons of low productivity (Sharma *et al.,* 1996; Tiwari, 2001). Soybean meal is preferred livestock feed because of its high protein content and low fiber content. Oil from soybean is mainly used by food processors in baked and fried food products or bottled into cooking oil (US soybean Export Council, 2008). Young seedlings of soybean do not use K, but the rate of uptake climbs to a peak during the period of rapid growth. The K in vegetative parts is transferred to seed during pod fill process. The matured soybean seed contains nearly 60% of the total K in plant (Hoeft *et al.,* 2000). The K concentration in soybean plants decreases near maturity and any deficit of K during the late vegetative and reproduction stages is going to reflect on yield of soybean. The uptake of nutrients by crop per unit weight of soil and the dry matter produced may be affected by climatic factors. For example, K uptake in the seedlings will be greater with the higher water supply, the proportional (%) increase differing with the nutrient (19–77%) in the general order Ca > K, Mg > P > N. (Beaton and Speer, 2006). Also, the potential yield will be reduced by either low temperatures which restrict vegetative growth or by high temperatures which prevent flower production (Menzel *et al*., 1998). Thus, the objectives of this research are; to determine how five different rates of potassium fertilizer applied on the three soybean cultivars will influence the vegetative growth, yield and most importantly their N, K and Ca contents.

Materials and Methods
The experiment was carried out at the Teaching and research Farm of the Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, Ogbomoso, Oyo state, Nigeria during the cropping season in 2016. Ogbomoso lies on the longitude 8° 10′ N and latitude 4° 10′ E and the temperature in the area ranges from 28°C to 33°C with relative humidity of about 74% all year found except in January when the dry wind blows from the north. The annual rainfall is about 1000

mm and is bimodal in pattern (Okotete, 2008; Oni *et al.,* 2015). The experiment was a 3 x 5 factorial experiment arranged in a randomized completed block design and replicated three times The factors are three cultivars of soybean (V1 – TGx 1987-62F medium maturing, V2 – TGx 1835-10E early maturing and V3 – TGx 1910-14F late maturing) sourced from the International Institute of Tropical Agriculture (IITA), Ibadan, and five rates of potassium application (0, 15, 30, 45 and 60 kg K/ha). Beds of 3 m by 2 m were made for each treatment plot and 15 treatment plots per replicate. Each treatment plot has 50 cm inter row spacing and 25 cm intra row spacing giving a total of 65 stands per treatment plot. Five plants were randomly selected from the net plot in each plot and tagged for the growth and yield data that were taken which include; number of leaves, plant height, dry pod weight, seed weight and shelling %. Nitrogen, Potassium and Calcium contents of the matured seeds for each variety were determined. Daily temperature and precipitation for the planting period were also recorded using the HOBO-Automatic weather station located about 100 m away from the experimental plot.Data collected were subjected to the analysis of variance (ANOVA) and means were separated using Least Significant Difference at 5% probability level.

Results and Discussion

Effect of level of potassium on growth parameters of soybean cultivar

Soybean variety and levels of potassium applied had no significant effect on the plant height (Table 1). Plant height at 0 kg K/ha was not significantly different compared with all others for the same cultivar. However, there was significant interaction between potassium level of K and variety on plant height. For instance at 8 WAP, the tallest plant height obtained from TGX 1987-62F (37.2 cm), TGX 1835-10E (42.1cm) and TGX 1910-1 (43.1 cm) were obtained when 30, 15, and 45 kg K/ha respectively were applied. The number of leaves data followed similar trend. This is in agreement with observation of Hungria and Franchini, (2000) that plant height of soybean responded to potassium application level. Also, Priyadharsh and Seran, (2009) who reported that 30 kg K/ha had the highest number of leaves for soybean.

Effect of potassium application on yield and yield parameters of soybean cultivars

The yield performance of TGX 1910-14F was significantly better than others. It produced the highest pod (2,984.9) and seed (1,542.9) weight per hectare (Table 2). The least production was obtained from TGX 1987-62F soybean cultivar treated with control (0 kg K/ha). The result presented in Table 3, showed that nitrogen (N) contents of soybean seed at different potassium rates were not significantly different from each other. The highest N content (6.6%) was obtained when 15 kg K/ha was applied while 60 kg K/ha gave the lowest N content (6.1%). The calcium (Ca) contents of soybean seed at different potassium rates were not significantly different from each other. The highest Ca content (3.1%) was obtained at 0 and 60 kg K/ha while 30 kg K/ha gave the lowest Ca content (2.7%). Also, the potassium rates had no significant effect on potassium (K) contents of soybean seed. The highest K content (2.1 %) was obtained at 0, 15 and 30 kg K/ha which were not significantly different from other treatments.

Climatic parameters of the experimental site in 2016

Daily record of solar radiation (SRAD), maximum temperature (Tmax), minimum temperature (Tmin) and rainfall during the 2016 growing season were recorded (Table 4). The result shows the average monthly record for each data. The seed received enough irradiation for germination (May) and there was no water stress during the flowering (June) seedling (July) periods.

Conclusion

In conclusion, each cultivar of soybean responded differently to levels of potassium tried. Planting of TGX1910-14F with application of 15 kg K/ha in the trial location maximized the productivity and nutritional quality of soybean.

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Table 1: Effects of Potassium Application on Plant Height (cm) of Soybean cultivars

Variety	K Level (kg K/ha)	WAP					
		3	4	5	6	7	8
TGX 1987-62F	0	8.1	12.6	24.5	25.0	24.0	24.5
	15	8.3	15.6	31.0	35.1	35.9	37.2
	30	8.0	13.6	26.4	30.1	29.6	31.1
	45	7.9	14.0	26.6	30.1	30.6	31.5
	60	8.1	15.2	27.5	30.0	30.9	32.8
TGX 1835-10E	0	8.1	15.5	30.9	38.4	38.9	40.5
	15	8.0	15.3	29.6	33.0	35.3	36.5
	30	8.7	17.6	33.8	38.5	41.2	42.1
	45	8.5	14.9	28.3	35.1	34.0	33.9
	60	7.6	11.8	26.0	29.4	30.6	32.2
TGX 1910-14F	0	8.5	15.0	27.3	33.3	34.9	37.3
	15	8.0	15.5	30.7	34.0	35.5	36.4
	30	8.8	16.6	31.4	34.0	34.6	38.3
	45	8.5	15.5	31.4	39.3	41.8	43.1
	60	8.6	17.7	31.8	35.9	37.4	38.3

Table 2: Effect of interaction of cultivar and level of potassium on yield and yield parameters of soybean

Variety	K Level (kg K/ha)	Pod weight (kg/ha)	Seed weight (kg/ha)	Shelling (%)
TGX 1987-62F	0	632.0	359.0	56.7
	15	1080.5	452.2	48.3
	30	1585.9	918.1	57.7
	45	1119.5	635.4	56.0
	60	1137.7	535.1	47.9
TGX 1835-10E	0	1628.3	986.0	59.8
	15	1287.4	680.8	54.9
	30	1706.6	853.5	53.8
	45	1584.7	658.0	50.7
	60	889.3	555.7	61.3
TGX 1910-14F	0	1428.8	836.7	57.7
	15	1739.5	1068.8	60.8
	30	2191.0	711.4	35.3
	45	1934.6	1166.6	60.1
	60	2984.9	1542.9	48.2
LSD(0.05)		306.54	159.56	11.96

Table 3: Effect of potassium application on Nitrogen, Calcium and Potassium content of soybean

K Level (kg K/ha)	Content (%)
	N
0	6.2
15	6.6
30	6.4
45	6.3
60	6.1
LSD	0.93
	Ca
0	3.1
15	3.0
30	2.7
45	3.0
60	3.1
LSD	0.73
	K
0	2.1
15	2.1
30	2.1
45	2.0
60	2.0
LSD	0.22

Table 4: Climatic data for the experimental site in 2016 at Ogbomoso

	SRAD (MJ/M²/D)	Tmax (°C)	Tmin (°C)	Rain (mm)
Jan	12.8	27.7	22.9	1.7
Feb	16.8	27.6	24.1	24.5
Mar	14.1	27.7	24.6	60.0
Apr	11.8	27.7	24.1	75.0
May	11.8	27.3	23.9	150.9
Jun	10.2	26.6	23.5	179.2
Jul	8.5	26.1	22.5	237.5
Aug	5.4	25.8	21.9	270.0
Sep	8.4	26.1	22.5	270.2
Oct	9.3	26.4	22.6	68.3
Nov	12.1	27.8	23.1	56.4